THIRTY-FIFTH ANNUAL REPORT

OF THE

NEW JERSEY STATE

Agricultural Experiment Station

312

AND THE

TWENTY-SEVENTH ANNUAL REPORT

OF THE

New Jersey Agricultural College Experiment Station

FOR THE YEAR ENDING OCTOBER 31ST

1914

PATERSON, N. J.
News Printing Co., State Printers.
1915.

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Letter of Transmittal.

To His Excellency, James F. Fielder, Governor of the State of New Jersey:

Sir—I have the honor to submit herewith the Thirty-fifth Annual Report of the New Jersey State Agricultural Experiment Station, as required by the law establishing the Station, which was approved March 10th, 1880, and which is chapter 106 of the laws of that year.

James Neilson,
President.

New Brunswick, N. J., November 30th, 1914.

To His Excellency, James F. Fielder, Governor of the State of New Jersey:

Sir—In compliance with an act of Congress, approved March 2d, 1887, and with an act of the Legislature of this State approved March 5th, 1888, I beg leave to submit, on behalf of the Trustees of Rutgers College in New Jersey, maintaining Rutgers Scientific School, the New Jersey State College, for the benefit of Agriculture and Mechanic Arts, the Twenty-seventh Annual Report of the operations of that department of the College which has been organized in accordance with said act of Congress, and is known as "The State Agricultural College Experiment Station."

W. H. S. Demarest,
President.

New Brunswick, N. J., November 30th, 1914.

Treasurer's Report.

Irving S. Upson, in account with the New Jersey State Agricultural Experiment Station, November 1st, 1913, to October 31st, 1914.

Appropriations for Salaries and Expenses.

RECEIPTS.

From State Treasurer	$33,484 18

PAYMENTS.

Salaries and Wages	$20,940 43
Advertising	34 97
Books and Magazines	39 50
Chemical Supplies	84 73
Coal	699 24
Electric Current	324 28
Express, Freight, and Cartage	306 50
Farm Machinery and Tools	557 59
Feed and Shavings	4,366 29
Fertilizers	2 70
Gas	96 41
Insurance	2 84
Livestock	500 00
Office Furniture	66 75
Office Supplies	425 26
Orchard Expenses	168 11
Photographic Supplies and Blue Prints	129 13
Postage	454 17
Printing and Stationery	1,429 22
Repairs	1,134 24
Scientific Apparatus	21 46
Team Hire	114 00
Telephone	472 08
Telegraph	1 97
Toward Maintenance of Mercer County Farm Bureau	100 00
Traveling Expenses—Managers	57 76
Traveling Expenses—Officers	456 97
Traveling Expenses—Sampling Fertilizers	150 28
Trees, Seeds, and Vines	42 05
Water and Ice	132 39
Sundries	172 86
Total	$33,484 18

Appropriation for Printing Bulletins.

RECEIPTS.

From State Treasurer	$ 5,000 00

PAYMENTS.

For Printing Bulletins	$ 5,000 00

Appropriation for the Purpose of Carrying in[illegible]o Effect "An Act to Pr[illegible] vide for Locating and Abolishing Mosqu[illegible]ito-Breeding Salt Mar[illegible] Areas Within the State, for Assistance in Dealing with Certa[illegible] Inland Breeding Places, and Appropriating M[illegible]ney to Carry Its P[illegible] visions into Effect."

RECEIPTS.

From State Treasurer	$ 7,437

PAYMENTS.

		$ 4,752
Salaries and Wages		120
Advertising		43
Hardware Supplies		90
Office Furniture		2(
Office Supplies		8:
Photographic Supplies and Blue Prints	1	
Postage		
Printing and Stationery	70	
Scientific Apparatus	3	
Telephone	231	
Telegraph	19	
Traveling Expenses—Officers	1,840	
Sundries	60	4
Total	$ 7,437	7

Appropriation for Repairs and Improvements in Experiment Station Building.

RECEIPTS.

From State Treasurer	$ 1,436 19

PAYMENTS.

For Repairs and Improvements in Experiment Station Building	$1,436 19

Appropriation for the Scientific Investigation of Oyster Propagation.

RECEIPTS.

From State Treasurer	$899 25

PAYMENTS.

Salaries and Wages	$307 25
Adding Machine	35 00
Chemical Supplies	12 75
Express, Freight, and Cartage	10 14
Hardware Supplies	17 58
Insurance on Boats	5 50
Office Furniture	25 50
Photographic Supplies	14 10
Postage	2 89
Printing and Stationery	2 70
Rent of Ground	15 00
Rowboat Motor	80 00
Scientific Apparatus	64 00
Storage of Boats	36 50
Telegraph	25
Traveling Expenses—Officers	245 99
Sundries	24 10
Total	$899 25

Appropriation for Carrying Out the Provisions of "An Act Concerning Seeds."

RECEIPTS.

From State Treasurer	$1,999 94

PAYMENTS.

Salaries and Wages	$1,787 20
Express, Freight, and Cartage	1 82
Hardware Supplies	1 20
Office Supplies	8 05
Photographic Supplies and Blue Prints	19 90
Printing and Stationery	19 42
Telephone	1 20
Traveling Expenses—Officers	157 16
Seeds	3 42
Sundries	57
Total	$1,999 94

Appropriation for the Maintenance and Operation of the Department of Poultry Husbandry.

RECEIPTS.

From State Treasurer	$9,662 51

PAYMENTS.

Salaries and Wages	$4,294 40
Advertising	15 00
oks and Magazines	33 19
emical Supplies	80 82
al	36 85
press, Freight, and Cartage	57 03
urance	128 46
ice Furniture	85 28
ice Supplies	334 69
otographic Supplies and Blue Prints	135 43
ultry Feed	3,295 20
ultry Supplies and Tools	405 67
stage	42 80
inting and Stationery	71 00
pairs	257 01
entific Apparatus	83 43
lephone	41 03
aveling Expenses—Officers	196 77
eds	2 65
ndries	65 80
Total	$9,662 51

propriation for Buildings, Fences, and Equipment in the Department of Poultry Husbandry.

RECEIPTS.

om State Treasurer	$1,499 76

PAYMENTS.

For Buildings, Fences, and Equipment in the Department of Poultry Husbandry	$1,499 76

Appropriation for the Purpose of Maintaining and Carrying on Experimental Work in Floriculture.

RECEIPTS.

From State Treasurer	$4,639 11

PAYMENTS.

Salaries and Wages	$2,635 00
Chemical Supplies	14 48
Coal	1,359 57
Express, Freight, and Cartage	2 79
Floriculture Supplies and Tools	99 54
Fertilizers	74 80
Office Supplies	81 00
Photographic Supplies and Blue Prints	19 23
Printing and Stationery	5 50
Repairs	133 03
Scientific Apparatus	67 67
Telegraph	58
Traveling Expenses—Officers	38 44
Trees, Seeds, and Vines	90 40
Water and Ice	12 05
Sundries	5 03
Total	$4,639 11

Appropriation for Carrying Out the Provisions of "An Act to Regulate the Sale of Insecticides."

RECEIPTS.

From State Treasurer	$990 77

PAYMENTS.

Salaries and Wages	$260 00
Chemical Supplies	468 18
Postage	4 32
Scientific Apparatus	254 62
Traveling Expenses—Officers	1 75
Sundries	1 90
Total	$990 77

Appropriation for Farm Demonstration in Agriculture.

RECEIPTS.

From State Treasurer	$4,974 12

PAYMENTS.

Salaries and Wages	$2,903 00
Express, Freight, and Cartage	1 95
Fertilizers	11 29
Office Furniture	47 06
Photographic Supplies	1 00
Postage	68
Printing and Stationery	27 25
Telephone	3 75
Telegraph	3 91
Toward Maintenance of Mercer County Farm Bureau	100 00
Toward Salary of Bergen County Superintendent of Farm Demonstration	500 00

Toward Salary of Monmouth County Superintendent of Farm Demonstration	500 00
Traveling Expenses—Officers	867 43
Seeds	6 15
Sundries	65
Total	$4,974 12

Fertilizer Inspection Fees Account.

RECEIPTS.

From State Treasurer	$21,985 20

PAYMENTS.

Salaries and Wages	$13,847 48
Advertising	3 00
Chemical Supplies	317 65
Coal	159 39
Electric Current	107 86
Express, Freight, and Cartage	273 78
Farm Machinery and Tools	322 31
Feed	729 41
Fertilizers	348 23
Gas	145 02
Livestock	20 00
Office Furniture	36 00
Office Supplies	226 89
Photographic Supplies and Blue Prints	198 06
Postage	308 52
Printing and Stationery	804 66
Repairs	354 26
Scientific Apparatus	4 50
Team Hire	80 00
Telephone	102 88
Telegraph	8 11
Toward Maintenance of Mercer County Farm Bureau	700 00
Traveling Expenses—Managers	27 27
Traveling Expenses—Officers	1,585 27
Traveling Expenses—Sampling Fertilizers	570 66
Trees, Seeds, and Vines	423 03
Veterinary Services	113 50
Water and Ice	7 35
Refund of Inspection Fees	23 25
Sundries	136 86
Total	$21,985 20

Feed Inspection Fees Account.

RECEIPTS.

From State Treasurer	$15,400 95

PAYMENTS.

Salaries and Wages	$6,411 73
Chemical Supplies	203 54
Electric Current	95 78
Express, Freight, and Cartage	177 61
Farm Machinery and Tools	219 38
Feed	2,848 54
Fertilizers	1,006 14
Gas	65 04

Livestock	420 00
Office Supplies	74 05
Photographic Supplies and Blue Prints	88 89
Postage	252 35
Printing and Stationery	870 07
Refund of Inspection Fees	139 05
Registration of Livestock	57 00
Repairs	293 98
Scientific Apparatus	40 15
Team Hire	80 00
Telephone	48 05
Telegraph	7 56
Toward Maintenance of Mercer County Farm Bureau	400 00
Traveling Expenses—Managers	17 85
Traveling Expenses—Officers	804 57
Traveling Expenses—Sampling Feeds	472 36
Trees, Seeds, and Vines	90 83
Veterinary Services	121 00
Water and Ice	38 11
Sundries	57 32
Total	$15,400 95

Collections Account.

RECEIPTS.

From Poultry Department—	
Collections for Sales of Poultry and Eggs	$4,664 29
From Floriculture Department—	
Collections for Sales of Flowers	1,660 46
From Horticulture Department—	
Collections for Sales of Peaches	1,847 39
From Dairy Department—	
Collections for Sales of Milk	4,734 62
From Swine Department—	
Collections for Sales of Swine	1,908 14
From Chemical Department—	
Collection of Fertilizer Inspection Fees	21,989 53
From Chemical Department—	
Collection of Feed Inspection Fees	15,459 15
Total	$52,263 58

PAYMENTS.

To State Treasurer—	
Collections for Sales of Poultry and Eggs	$4,664 29
To State Treasurer—	
Collections for Sales of Flowers	1,660 46
To State Treasurer—	
Collections for Sales of Peaches	1,847 39
To State Treasurer—	
Collections for Sales of Milk	4,734 62
To State Treasurer—	
Collections for Sales of Swine	1,908 14
To State Treasurer—	
Collection of Fertilizer Inspection Fees	21,989 53
To State Treasurer—	
Collection of Feed Inspection Fees	15,459 15
Total	$52,263 58

The Auditing Committee of the Experiment Station has examined the accounts of the Treasurer of said Station, and has found them correct.

(Signed) GEORGE E. DE CAMP,

BENJ. LIPPINCOTT,

Auditing Committee.

Financial Statement.

The Trustees of Rutgers College

for

The New Jersey State Agricultural College Experiment Station

in Account with

The United States Appropriation, 1913-1914.

RECEIPTS.

Balance from Hatch Act, 1912-1913	$ 2 00
From the Treasurer of the United States—	
Hatch Act (1913-1914)	14,998 00
Adams Act (1913-1914)	15,000 00
	$30,000 00

DISBURSEMENTS.

	Hatch Act	*Adams Act*	
Salaries	$ 8,863 75	$11,020 00	$19,883 75
Labor	1,256 37	1,495 17	2,751 54
Publications	74 10	....	74 10
Postage and Stationery	769 86	17 09	786 95
Freight and Express	38 89	2 22	41 11
Heat, Light, Water and Power	1,062 41	285 20	1,347 61
Chemicals and Laboratory Supplies	353 28	686 39	1,039 67
Seeds, Plants and Sundry Supplies	293 96	393 10	687 06
Fertilizers	18 19	145 06	163 25
Feeding Stuffs	....	360 00	360 00
Library	384 41	101 02	485 43
Tools, Machinery and Appliances	274 82	59 29	334 11
Furniture and Fixtures	222 60	....	222 60
Scientific Apparatus and Specimens	352 10	3 08	355 18
Livestock	....	....	....
Traveling Expenses	1,035 26	12 36	1,047 62
Contingent Expenses	....	....	....
Buildings and Land	....	420 02	420 02
Balance	....	....	....
	$15,000 00	$15,000 00	$30,000 00

We, the undersigned, duly appointed Auditors of the Corporation, do hereby certify that we have examined the books and accounts of the New Jersey State Agricultural College Experiment Station for the fiscal year ended June 30th, 1914; that we have found the same well kept and classified as above; that the balance brought forward from the preceding year was $2.00 on the Hatch Fund and $...... on the Adams Fund; that the receipts for the year from the Treasurer of the United States were $14,998.00 under the act of Congress of March 2d, 1887, and $15,000.00 under the act of Congress of March 16th, 1906, and the corresponding disbursements $15,000.00 and $15,000.00; for all of which proper vouchers are on file and have been by us examined and found correct, thus leaving balances of $...... and $.......

And we further certify that the expenditures have been solely for the purposes set forth in the acts of Congress approved March 2d, 1887, and March 16th, 1906, and in accordance with the terms of said acts, respectively.

(Signed) W. H. S. DEMAREST,

J. G. LIPMAN,

Auditors.

Supplementary Statement.

RECEIPTS.

Sale—Team of Mules	$285 00

DISBURSEMENTS.

Tools, Machinery and Appliances	$ 20 55
Livestock	260 00
Buildings and Land	4 45
	$285 00

Report of the Director.

Increasing complexity of work and problems is characteristic of the American Experiment Stations. In the earlier years of their existence, there was often lack of differentiation between research, extension and control work. The men in charge of departments had to look after teaching, investigation and miscellaneous activities which are at present grouped under extension work.

Thanks to the more ample means which have been placed at the disposal of the Experiment Stations, not only by the Federal Government, but also by the several States, the Stations have been able to systematize their work, to organize new departments, and to differentiate the activities within the institution and the individual departments.

More recent legislation on the part of both the States and the Federal Government, has emphasized the importance of the Agricultural Colleges and of the Stations which are an integral part of them, as educational agencies. These institutions are expected to serve as Bureaus of Information, and to provide instruction of one sort or another, to persons not resident at the institutions themselves. Moreover, problems of co-operation, transportation and marketing are now claiming much more attention than they have in the past, and the Agricultural Colleges and Experiment Stations are expected to do their share in helping to solve these problems. There has been a tendency, likewise, to call on the Stations for the study of various agricultural questions under local conditions. Some of the Experiment Srations have established experimental farms at different points in the State, for the purpose of demonstrating progressive methods of farming, under the given conditions, as well as of providing data of possible scientific value. Aside from such experimental farms, there are numerous co-operative experiments dealing with local phases of the various agricultural questions.

Because of the material expansion of the Experiment Stations, and the taking up of the study of new problems, the administration of these institutions has become a matter less simple that it formerly was. The Experiment Station Director, has less time nowadays for investigation or teaching; he must give nearly all of his time to fiscal or administrative matters. He is obliged to systematize the business of the institution, so that a more clear-cut division of its activities may be made. For this reason, much is being said nowadays of the administration of the Experiment Station by projects. Research and extension work may thus be carried on under a number of projects, to facilitate not only the preparation of the budget for the year, but to secure a better balanced organization.

The facts just noted, apply to the New Jersey Stations as they do to others. In the College Station, the research activities are already grouped under projects, especially in the Departments of Botany and of Soil Chemistry and Basteriology. More recently, an attempt has been made to outline the work also of the other Departments of the College Station, as well as of that of the State Station on the project basis. The research and extension work of the institution is bound to profit by the more systematic administration of the work.

In outlining these projects, it has been the aim of the members of the Staff to recognize local needs, and to contribute to the answering of questions arising within the State.

CURRENT AGRICULTURAL PROBLEMS.

The Experiment Stations are brought directly in touch with both general and specific questions affecting the agriculture of the State. Among the questions often referred to the members of the staff are those which concern the production as well as the marketing of agricultural comodities.

Soils.

The problems in production deal to a great extent with soils, their fertility and their adaptation to various crops and crop systems. In the southern portion of the State, much of the unimproved land is being put under cultivation. Slowly, the territory now covered by scrub oak and pine is being converted into farm land.

The progress of this reclamation is slow and uncertain, since there are no cheap methods available for the clearing and the making arable of poor land of this type. Experimental work dealing with economic methods of clearing southern New Jersey pine lands and of making them fairly productive is needed. When these methods are systematized and made available to the average settler, the reclamation will proceed more rapidly and will help to bring prosperity to a large portion of southern New Jersey.

There is a growing interest at present, both in drainage and irrigation. Some of the most fertile land in the State cannot at present be utilized for crop production, on account of lack of suitable drainage. It is recognized by persons who are well acquainted with land of this type, often purchasable at $10. per acre, or less, that it may be made worth $200. or $300. per acre after it is drained, and rendered productive by the use of lime and of commercial fertilizers. The next decade or two will witness the reclaiming of vast areas of such land now practically worthless and serving as mosquito-breeding areas.

The old ponds and lakes in the glaciated area of the State, full of vegetable matter, the meadows bordering our streams and lakes and the numerous low-lying areas, both in southern and northern New Jersey, are certain, with proper drainage, to become extremely valuable for the growing of truck crops, as well as of forage crops for domestic animals.

Irrigation, especially over-head irrigation, is now claiming the attention of progressive farmers in the State. A fairly large number of over-head irrigation systems have already been established, notably in Cumberland, Burlington and Monmouth counties. Irrigation plants also exist in other counties of the State, and are evidently used wirh success in the production of vegetables, friuts and berries, under intensive conditions. An attempt has been made by the Training School, at Vineland, N. J., to utilize over-head irrigation in connection with alfalfa growing. The results of these tests should be of interest to dairy farmers in the State.

Because of the increasing value of farm lands in New Jersey, leading to an increase in the fixed charges to be met by the owners or renters of these lands, it has become necessary to attempt more intensive system of farming, and to assure greater gross and net returns per acre. It is but natural that under such conditions, farmers should give more careful study to problems of soil fertility. Evidence in this direction is furnished by unceasing calls for information on the composition and value of commercial fertilizers; on the composition and use of agricultural lime, and on methods relating to the main tenance of soil fertility by means of commercial forms of plant-food and of green manures. The census figures of 1910 bring out with much distinctness, the fact that the propaganda of the Experiment Stations emphasizing, especially, methods for the conservation and maintenance of soil fertility are now bearing fruit. In spite of the progress made by the farmers of New Jersey in improving the soil, the greater number of them are still far from having attained a clear understanding of the needs of their land and of the most effective and economical methods of providing for these needs. The farmers of New Jersey are not using enough lime, nor are they providing an adequate supply of organic matter to replace that which is lost under prevailing methods of tillage and cropping. To a great extent, the important soil fertility problems of New Jersey relate to soil reaction and soil organic matter fully as much as they relate to the supply of available plant-food for the growing crops.

Horticultural Interests.

The horticultural interests of the State are becoming relatively more prominent from year to year. Within the past five years, there has been a striking increase in the area devoted to orcharding. Thousands of apple, peach and pear trees have been set out, especially in South Jersey. Burlington, Gloucester, Salem, Cumberland and Atlantic Counties are especially to be noted in this respect. Similarly, there has been a very marked expansion in the area utilized for the growing of vegetables for the market.

The greater importance of fruit growing and of market gardening, coupled with that of floriculture, is lending much distinction to the horticultural interests of the State. New Jersey already possesses a

reputation for the production of choice fruits, vegetables and flowers. It is not likely that this reputation for quality will suffer in the years to come, if one is to judge by the intelligence and discrimination that the horticulturists of the State are now displaying. But while there has been gratifying advance in this agricultural industry, it must be admitted that the adoption of more intensive methods and the expansion of the areas devoted to horticultural crops will increase the danger of injury from both insect enemies and fungous diseases. Even now, the truckers and fruit growers of New Jersey are confronted by serious problems, which the Entomologist and Plant Pathologist of the Experiment Station cannot always attempt to solve, because of their limited resources.

Livestock Interests.

A great change has come over the livestock interests of the State within the past decade or two. Milk production in central and southern New Jersey has shrunk to a marked degree. Northern New Jersey is hardly holding its own in so far as the older methods of production and distribution are concerned. On the other hand, there has been growth in certain directions, especially in the establishment of socalled "certified milk dairies," and the production of milk with a low bacterial count. Such milk is sold at a price much above that of ordinary market milk. These dairy establisbments often containing herds of choice dairy animals, belonging to the leading breeds; Holstein-Friesians, Guernseys, Jerseys and even Ayrshires and Brown Swiss have already achieved distinction among breeders in this and other States.

There seems to be a revival now, in hog raising. Thanks to our recently acquired knowledge of the causes and methods for controlling hog cholera, progressive farmers feel encouraged to increase the size of their herds. The Experiment Stations are making a valuable contribution to this branch of our livestock industry, by conducting feeding and grazing experiments with various breeds of swine. It seems, now, that even under Eastern conditions, pork can be produced economically and to the advantage of both the producer and the consumer.

In view of the changes in the dairy situation, in view of the revival of swine production, and the growing interest in sheep husbandry, to say nothing of the wonderful growth of the poultry interests of the State, it seems proper, at this time, to suggest the organization of a Livestock Breeders' Association of New Jersey. The proposed Association should include, at least, the breeders of dairy cattle, of swine, sheep and perhaps of horses. An Association of this type should prove to be an educational factor of importance, should encourage the distribution of better animals for breeding purposes, and should in many ways help the owners of domestic animals to produce and to market animals and animal products with less waste and greater profit, both to themselves and to the consumer.

Soil and Farm Surveys.

In recognizing the basic significance of the soil in agricultural progress and prosperity, we must make provision for completing the soil survey of the State and for supplementing it with such agricultural surveys as would give us a better understanding of the methods in vogue at present, and as would point out to us the errors and defects, that should be corrected. The earliest of the soil surveys made in this State, was that of the Salem Area in Southern New Jersey. This was followed by the survey of the Trenton Area in Central New Jersey. Both of these were made by the Bureau of Soils, of the U. S. Department of Agriculture, and were completed between 1900 and 1902. Since that time, the Geological Survey of New Jersey, the Experiment Station and the Bureau of Soils, of the U. S. Department of Agriculture, have co-operated in making soil surveys in various parts of the State. The Sussex Area, comprising, in all, more than 500 square miles, was surveyed by the co-operating parties, as was also the Monmouth Area, of about 300 square miles. Another similar area is now being surveyed in South Jersey. Within a few years, all of the improved area of the State will have been surveyed, and the different soil types will have been outlined and mapped. The soil surveys will be used as a basis for crop surveys, as well as for farm management surveys. Such surveys will deal in a comprehensive way with problems of soil fertility, crop and animal production and the economic phases of transportation and marketing. It need hardly be pointed out here, that such surveys will furnish extremely valuable data on which may be based recommendations for the improvement of some of the methods at present employed.

Branch Experiment Station.

For some years, the people of South Jersey have advocated the establishment of a Branch Experiment Station at some central and easily accessible point in South Jersey. There has been no organized effort made to secure a Branch Experiment Station for South Jersey, even though the recognition of the need for an institution of this nature is widespread among the progressive farmers of the State. It is felt that, because of the peculiar soil and crop conditions of southern New Jersey, the local problems can not be studied to full advantage by the members of the Station staff at New Brunswick. It is felt, likewise, that there is no need for duplicating the laboratory and building equipment of the present Station. The laboratory studies and investigations pertaining to southern New Jersey soils and crops can be carried on without difficulty at the Central Station. On the other hand, the study of specific field problems could only be conducted locally, if adequate returns are to be secured. For this reason, it is highly desirable that a farm containing soil types representative of those most prevalent in South Jersey be purchased. This farm could be utilized for the study of economical methods for the clearing and the making arable

of new land, and for the improvement of such lands by means of commercial fertilizers, lime and of green manures. Insect problems, peculiar to the crops grown on sandy and gravelly soils could be studied there to advantage, as could also problems dealing with tillage, irrigation, drainage and the testing out of crop varieties which seem most promising for southern New Jersey. The intitial cost of land and buildings, of the proposed Branch Experiment Station, need not exceed the sum of $50,000. The annual maintenance charges should not exceed $10,000. per annum, especially if the returns from the crops raised on the place be credited to the institution.

Co-operation and Marketing.

The high cost of food stuffs is forcing the city dweller to study more carefully the problems relating to food producting, and to understand more clearly the causes which determine the prices paid for agricultural commodities in the city markets. In order to reduce the cost of food stuffs, the city dweller is now trying to join with his neighbor in encouraging the establishment of city markets, the organization of consumers' leagues, and the utilization of parcel post and such other agencies as may help him to lighten the economic burden which he is now carrying. Through the medium of the press, and through his representatives in congress and in the State legislature, he is attempting to reach the producer and to learn of ways and means that would make the present methods of transportation and distribution less costly.

The farmer, on his part, is recognizing the possible gains which might accrue to him as well as to the consumer, if co-operative methods could be employed, in the marketing of farm products. In response to this recognition on the part of both the producer and the consumer, the Experiment Station, through its Extension Department, is making a study of methods which promise a successful solution of the problem. The Station's representative in Bergen County has helped to create an interest in co-operative marketing and the organization of city markets. Partly through his efforts, a city market has been established in Jersey City. In the same way, members of the Station staff have encouraged the formation of Associations of Producers, have studied the value of the parcel post for marketing farm products and have generally kept the question before the farmers of the State. This agitation is bound to produce results.

Suburban Problems.

New Jersey has a very large suburban population. The people of our suburban communities have adirect interest, if not in farming, at least in gardening. They are interested in the growing of vegetables, of berries, of fruit and of flowers, and, in consequence, have soil, plant and insect problems of their own. They naturally turn to the Experiment Station for help in solving these problems. They are more ready to write than the average farmer, and usually expect careful and detailed advice as to the best methods of growing plants in their gardens

or greenhouses. It has always been the aim of the Experiment Station to serve, as far as possible, the interests of this portion of our population. As a result of this, many letters are received by the Station from our suburban population, asking for advice in many matters, asking also for printed matter and for personal visits from members of the Staff of the Station. That this service is helpful, is evidenced by the many expressions of appreciation which come to us. It is gratifying for the members of the Station Staff to feel that, without neglecting the interests of the farmers themselves, they are able to serve another and very large constituency, to whom gardening is often a source of profit and always a source of pleasure.

Mosquito Problems.

While not directly an agricultural problem, mosquito extermination is of tremendous indirect significance to rural New Jersey. It will scarcely be disputed that the failure of southern New Jersey to develop faster than it has developed, is due largely to the mosquito plague which infests a zone more than twenty miles wide, along the Eastern portion of South Jersey, as well as of the Western portion of Cape May and Cumberland Counties. But for the impossible living conditions created by the presence of the mosquitoes at certain portions of the year, much of the forest lands of the State would have been converted by this time into productive farms. The extermination of mosquitoes will bring to South Jersey and to portions of Middle and Northern New Jersey, an enhanced agricultural prosperity and a larger population. It will help to create enormous values. Much progress has already been made in mosquito extermination by the ditching of the salt marsh lands, where the breeding of the salt marsh species occurs. Of the 200,000 acres of salt marsh, about 70,000 acres have already been ditched, and it is expected that the counties concerned will at least provide funds sufficient for keeping these ditches open. It is hoped, furthermore, that this work will be expedited by the granting of more generous appropriations by the State for the draining of salt marsh areas. Possibly, the use of prison labor may provide the best means for completing this work within a few years, and for ridding southern New Jersey of a troublesome pest. Meanwhile, the scientific and practical results achieved by the late Dr. J. B. Smith, and his successor, in the study of the different species of mosquitoes, and the methods of their elimination, are recognized as being of extreme importance by Entomologists of the new and the old world.

THE YEAR'S RECORD.

Control Work.

To the control work of former years, there has been added the collection and analysis of samples of lime sold in the State. This has added to the responsibilities of the State Chemist, and his associates, by

increasing the amount of analytical work which must be done in ou laboratories, in connection with the analysis of samples of fertilizers feeding stuffs and insecticides. It is shown elsewhere in this report that about 17,700 determinations were made in the past fiscal year on these and other materials.

The farmers and manufacturers in the State recognize the importanc of this control work, in discouraging fraud and in helping the purchase of these commodities to reach an intelligent understanding of th agricultural and commercial value of these materials.

Similarly, in the case of the seed control, there has been a very marke increase in the number of seed samples submitted to the Seed Analyst by farmers and dealers. That the assistance thus rendered by the see control is fully appreciated, is indicated by written and verbal ex pressions by residents of the State, as well as by the sending of a con stantly increasing number of samples. It is scarcely necessary to poin out at this time that by assuring a better supply of seed to farmer and gardeners in New Jersey, the Experiment Station is helping to pro vide for larger crop yields and for the elimination of troublesom weeds. Formerly, our State was the dumping ground for much in ferior seed. At present, the dealers appreciate the value of the educa tional work conducted by the Seed Analyst and are furnishing to th local trade seed of better quality. Our Seed Law, while simple in character, is evidently adequate for meeting the existing needs. Never theless, it could be made even more helpful and efficient by being s amended as to call for a printed statement in connection with eacl lot of seed sold, showing the purity and germination co-efficient of tha seed. This would constitute a guarantee similar to that given b manufacturers of and dealers in commercial fertilizers and feedin stuffs.

The Entomologist and Plant Pathologist of the New Jersey Sta tions, are employed also by the State Board of Agriculture, and ar made responsible for the inspection of nurseries against the introduc tion and spread of injurious insects and plant diseases. This is a forr of control or police-work, which is extremely important. Thanks t the co-operation between the Experiment Station and the State Boar of Agriculture, residents of the State are protected against much ser ious economic loss, which might be caused by these pests.

Investigational Activities.

A reasonably full record of the investigational activities of th several departments of the Stations is presented in the following pages By way of a summary, mention may be made of some of the mor important features of the investigational work, conducted within th year just past.

But little opportunity is now offered to our control departments fo carrying on research work. Nevertheless some work of this characte is done even in these departments. The Chemist and his associate

have carried on studies of analytical methods, while the Seed Analyst has made a study of the occurrence and distribution of weed seeds in samples of commercial seeds. A study has been made by him, also, of the character of lawn grass mixtures sold in the East, and of the suitability of different mixtures for the establishing of lawns on different soil types. An interesting study is also being made of the value of alfalfa seed derived from different sources.

Investigations on the production and marketing of peaches have been conducted as in the past by the Horticulturist and his associates. Gratifying results have been obtained in the study of fertility problems, as well as of cultural and variety problems involved in commercial peach growing.

In the floricultural work, there has been undoubted progress, especially in the study of lime and of humidity as factors in the production of roses and carnations, for the market. The plant breeding work with carnations continues to contribute significant data to an important subject. It is expected, further, that the investigational work with market garden crops will continue and increase in scope and value.

Insofar as his other duties would permit, the Animal Husbandman of the Station has conducted investigations on methods of producing pork economically under Eastern conditions. A large herd of swine has been utilized for pasture experiments with various crop mixtures. Some promising results have been obtained with several forage crops, notably rape, sweet clover, alfalfa and soy beans. It appears now, that hogs could be pastured on relatively high-priced Eastern land and yet bring a fair profit to their owners. It has, also, been shown in these investigations that the housing problem is, at least under New Jersey conditions, a fairly simple one, since brood sows can be wintered in colony houses constructed at a slight cost. Further data have been obtained on the use of Digester Tankage, as one of the ingredients of profitable hog raising. Of the many visitors who come constantly to the College Farm, a large number have been especially interested in this work of the Animal Husbandry Department.

In the Poultry Department, emphasis was laid in the past year on experiments dealing with the feeding of poultry. Especial attention was given to an inquiry into the value of soured skim-milk in chick feeding, as well as the feeding of mature fowls for egg production. A comparison was made also of material both of animal and vegetable origin, as a source of protein for poultry. The experiments in breeding for egg production and inheritance of color pattern have also been continued with results of considerable value. Additional contributions have, likewise, been made by the Poultry Department to our knowledge of poultry house construction.

The experimental work of the Dairy Department has consisted of feeding experiments on the relative value of soiling crops and alfalfa hay as a source of roughage for the dairy animals during the summer months. A similar comparison has been made of soiling crops and

corn silage as a source of roughage for growing calves and heifers. Other lines of work included the keeping of herd records of production, and of the cost of raising calves.

A large mass of material has been accumulated in the records of the Cow Testing Associations of the State, as well as in those of the advanced registry tests, which may be used in time as a basis for the study of economical methods of feeding for milk production.

In connection with the feeding experiments in the Dairy Department, information of a supplementary character has been obtained in the Department of Farm Crops. Records have been kept on the cost of growing alfalfa for use in the Dairy Department, as well as of growing corn for the silo. Similar information has been obtained on the cost of growing mixed timothy and clover hay, and also of soy beans. Especial attention has been given here to the study of fall dressing with nitrogenous fertilizers as bearing on the profitable production of large crops of timothy.

The Department of Soil Chemistry and Bacteriology has followed the lines of investigation outlined in former reports. Questions relating to the accumulation and utilization of atmospheric nitrogen; to the availability of various nitrogenous materials; to the influence of lime on the maintenance of soil fertility; and to the various factors influencing the protein content of soy beans and of other crops, have been under investigation. Laboratory studies on the ammonification of organic matter in soils have been carried on and considerable attention has been given to the study of certain soil fungi as factors in the ammonification of soil nitrogen. Pot experiments carried on both in the greenhouse and in the cage adjoining the cylinder plot, have been conducted for the purpose of answering miscellaneous questions in the domain of soil fertilty.

A further addition has been made by the Biologist of the Experiment Station to our knowledge of oyster propagation. Investigations have been continued at Tuckerton and elsewhere along the coast, with a view, particularly, toward learning more about the conditions which determine the set of socalled "seed" or "spat." The rather peculiar climatic conditions of the past season permitted some unusual observations, which in time are bound to give us a clearer understanding of the causes which restrict tbe abundance and vitality of young oysters.

In the investigations carried on by the Botanical Department, the projects on heridity, toxicology, sap circulation and environment, have been continued. The first of these has received the most attention. The facts gathered within the past twelve months are a distinct addition to the existing knowledge on plant breeding.

Notwithstanding the preoccupation of the Entomologist with the work of mosquito extermination and nursery inspection, he has found time for the study of several important entomological problems. Among these may be included experiments on the dusting of potato foliage conducted at Elmer, Freehold and Robbinsville, and the investigations

on methods of fly control. Moreover, the mosquito extermination work has permitted the study of question relating to the breeding and distribution of these insects. The results in question are of undoubted value.

In summarizing the work of the Department of Plant Pathology, mention should be made of investigations dealing with the relation of tannin to the chestnut-bark disease, the influence of sulphur on the control of potato scab and, likewise, the value of sulphur and of other materials in the control of certain insect and fungous enemies of the potato. Similar studies have been made, as a part of our investigations in apple growing, relating especially to the use of sulphur for the control of fungous diseases and insects, as compared with the recognized standard treatments now in more or less general use. Mention should be made, also, of pear orchard investigations, the study of peach yellows and little peach, and the study of crown gall in nurseries.

Aside from the research work referred to in the above pages, there has been a considerable volume of miscellaneous research conducted by the different members of the Staff and by Seniors and Graduate Students at the College. While it is impossible to mention all of these in a brief resume, recognition should be made at this time of the very promising fertilizer and soil investigations in cranberry bogs outlined and begun by Mr. John H. Voorhees, as well as of studies on soil protozoa conducted by several students under the direction of Dr. Floyd E. Chidester, of the State Agricultural College.

Extension Service.

The Director's Report of 1912-13 contains a reference to the various extension activities of the institution. A share of this extension service is performed by each of the Departments of the Station, even though the bulk of it is rendered by the Extension Department. Each Department must supply information of a more or less technical nature to the numerous correspondents; indeed, the organization of the Extension Department for the specific purpose of furnishing information of a miscellaneous character has not in all cases helped to relieve the research departments of their share of letter writing. There are technical matters, which can only be answered by the research specialists, and these matters must be referred by the members of the Extension Department to the persons best qualified to answer them. The organization of County Bureaus and the educational propaganda carried on by the extension representatives in the different counties, have helped still further to swell the volume of correspondence. Under these conditions, it became necessary to add to our clerical staff and to provide larger sums for stationery, postage and miscellaneous office supplies. Still further growth is to be anticipated in this field of the Station's activities.

In addition to the information furnished by personal letters, residents in this and other States have obtained information and instruction from the Station through its bulletins, circulars and press letters. As in former year, the Extension Service as also contributed toward the

development of a more progressive agriculture in the State by visits of members of the Station staff to individual farms, by lectures at Farmers' Meetings by Field Meetings at the College Farm, and by courses of lectures offered during Farmers' Week. Other extension activites have included demonstration experiments, the judging of exhibits at Agricultural Fairs, and elsewhere, the organization of Boys' and Girls' Clubs and the organization of County Bureaus. The last-named deserve especial consideration as a means for creating wealth in the rural districts of our State.

Acknowledgment should be made at this time of the gain which has come to the Experiment Station from co-operation with other organizations in the State. The Director of the Stations feels particularly grateful to the members of the Executive Committee of the State Board of Agriculture, and to the State Board of Agriculture in general, for the moral support which they have extended to the Station. The two organizations have co-operated in the conducting of some of the control work of the State, as well as in the conducting of educational work through Farmers' Institutes, Field Meetings and Farmers' Week exercises. The members of the Staff of the Experiment Station have always been willing to offer their help and co-operation, as well, to the State Horicultural Society, American Cranberry Growers' Association, and the Poultry Organizations of the State. To this co-operation and willingness to contibute in every possible way to the prosperity of our agricultural interests may be attributed much of the progress that has been made. However, the Experiment Station has not limited its service and advice to agricultural organizations alone. Among other State institutions, the State Hospital for the Insane, at Morris Plains, the New Jersey Reformatory, at Rahway, the New Jersey State Prison, at Trenton, the State Tuberculosis Hospital at Glen Gardner, the State Home for Girls at Trenton, the New Jersey Reformatory for Women, at Clinton, and other institutions have felt free to call upon the members of the Station Staff for advice as to the purchase of fertilizers, feeding stuffs, insecticides, limes and other agricultural commodities, as well as to agricultural practices of interest and importance in each particular case. It is hoped that the Experiment Station will be in a position, even in a larger way, to offer helpful advice to the various State, County and private institutions serving the people of New Jersey. It has been the policy of the Station to give especial consideration to such institutions, to the extent of authorizing members of the Station Staff to visit these institutions and to look carefully into each particular problem, so as to provide for its most effective solution.

It seems, at present, that the establishment by the State Department of Education, of Vocational Schools in the different counties of the State, may call for more intimate relation between these two Departments. It is likely that the extension representatives in each County will be in a position to render effective aid to the instructors in the

Vocational Schools, by supplying technical information, either directly or through the specialists of the Experiment Station Staff. It is possible, also, that the county representatives may be able to place at the disposal of the pupils in these schools, seeds, plants and fertilizer materials, that could be used for teaching purposes.

Land, Buildings and Equipment.

Thanks to the generosity of Mr. William H. Leupp, and of other Trustees and friends of the College, the area of the College Farm has been somewhat increased by the purchase of several small tracts of land adjoining the Smock Area. A more important addition to the material equipment of the College has been made by Mr. Jas. Neilson, a Trustee and warm friend of both the College and Station. At his suggestion, a tract of woodland, containing in all about 32 acres, is to be utilized for experimental work in forestry. This land, now owned by Mr. Neilson, is to be placed by him at the disposal of the College and the Forest Park Reservation Commission of New Jersey, for the study of methods relative to the conservation of farm wood-lots. The area in question adjoins the forestry nursery on the Smock Tract.

The forestry nursery just mentioned will be included in the new site on which our Poultry Plant is to be developed on a larger scale. It is proposed to investigate the value of young forest trees in providing shade for poultry. Having been made a part of our poultry ranges, the forestry nursery should serve in helping to determine to what extent forestry and poultry husbandry may be combined. All told, the Poultry Plant will have at its disposal more than 20 acres of land for building sites and ranges. A portion of the lowlying area in this tract has been converted into a duck pond, which is to be used for experimental work in duck raising. The Poultry Husbandman of the Station feels that with this site and the additional buildings and equipment to be made available in the near future, the Poultry Plant of the Station should be fully as good as any experimental poultry plant in the United States.

A most important addition to our buildings has been provided by the completion of the Agricultural Building, at the College Farm. A statement concerning the funds appropriated for the construction of this building, as well as the planning of it, is contained in the Report of the Director for 1912-13. This building is now completed and is occupied by Departments of the College and the College Experiment Station. To some extent, the building is also used by members of the State Experiment Station Staff. On the ground floor of this building are located the offices of the Director and Financial Clerk, of the Extension Department and the Horticulturist. A classroom and horticultural laboratory are also located on this floor. On the second floor, there are located a large agronomy laboratory, for both four-year students and short course students, the offices of the instructors of agronomy and dairy husbandry, as well as the office of the Botanist

and of assistants in the Horticultural Department. Two large laboratories on this floor are occupied by the Botanist, and a large room has been reserved as a library and reading room. The upper floor of the building has well equipped laboratories and offices, occupied by the Departments of Soil Chemistry and Bacteriology, Plant Pathology and Seed Control. A large auditorium, with a seating capacity of 626, a soil fertility and soil physics laboratory, soil grinding room, bulletin room, storage room and lavatories are located in the basement.

The building itself is constructed of dark red brick and terra cotta, and is very attractive in appearance. It is of fire-proof construction, and is well lighted and heated. Thanks to the completion of tbis building, much of the work of the College and Station, formerly done in the Experiment Station Building, at Bleecker Place and Hamilton Street, is now to be carried on at the College Farm. This is, indeed, fortunate since it helps to conserve the time of a number of the members of the Staff, a portion of whose experimental material is located at the College Farm.

It is gratifying to note that the appropriation of $20,000, for the equipping of the Agricultural Building has been expended in providin a modern laboratory and office equipment. The Leonard Peterson Co., of Chicago, Ill., who supplied laboratory furniture and equipment, the American Seating Co., of Chicago and New York City, who furnished the opera chairs for the auditorium and horticultural classroom, and the Globe-Wernicke Co., who supplied office furniture and equipment, have met their contracts in a manner very satisfactory to the members of the Station Staff.

Aside from the Agricultural Building, the construction work at the College Farm has been rather limited within the past fiscal year. Out of funds available from Federal sources to the College Experiment Station, a new range of glass was built at the College Farm, in connection with the greenhouses now used by the Bacteriological Department. The new greenhouse is to be used by the Soil Department, for research work in soil fertility and soil bacteriology. It is hoped that still another range of glass will be made available in the near future, so that more adequate greenhouse facilities may be placed at the disposal of tbe Soil Department.

A number of small colony houses have been constructed in the Department of Animal Husbandry and Poultry Husbandry. The Director wishes to express his gratification at this time that the Public Service Company has carried out its wires to the Dairy Farm, on Rider's Lane, and that the cow barn has been wired and provided with electric connections. Power has also been provided for the running of motors, and it will now be easier for the management of the Dairy Farm to maintain an adequate water supply at the farm and in time, also, to have a refrigerating plant for the cooling of milk and other dairy products. It is also gratifying to note that the College greenhouses and piggery have been wired and that a telephone exchange

system has been installed, which provides telephone communication with the outlying portion of the College Farm. A better and more efficient organization of the administration and research work has thus been made possible.

Communication among the Departments of the Station has been made easier, and less costly, while much saving has no doubt been effected, thanks to the ability of the members of the Staff to communicate with one another without leaving their offices. The Telephone Exchange includes stations at the Dairy Farm, the new Poultry Farm the greenhouses of the Agricultural College Experiment Station, the horse barn, the farmhouse, the Short Course Building, the floricultural greenhouses, as well as Jersey Hall and the Entomology Building. As stated above, it also provides service within the Agricultural Building itself.

A comprehensive plan for the development of the grounds at the College Farm, has been prepared by Mr. Warren H. Manning, of Boston, Mass. This plan has been modified and added to by Mr. Albert D. Taylor, of Cleveland, Ohio. Sites for future buildings have been indicated, the construction of roads and walks has been outlined, and ornamental plantings and other features of landscape improvement have been described. The map prepared by Mr. Taylor, will be used in the development and improvement of the College Farm grounds. A great deal of grading has been already completed in the vicinity of the Agricultural Building. It is hoped that a large portion of the work will be completed in the spring of 1915, that lawns will be established, and ornamental and shade trees planted.

It may, also, be noted at this time, that Nichol Avenue, the main avenue of approach to the College Farm grounds, has been graded in part and that it is proposed to do additional grading in the spring. If funds were available, this street would be paved and curbed and water and sewer mains laid down. It need hardly be pointed out here, that it is essential to have attractive approaches to the College Farm grounds. Aside from the mere matter of attractiveness, it is important that access to the Farm be made easier and more convenient than it is now to both pedestrians and horse and motor drawn vehicles. Several thousands of dollars invested in these improvements would help to make the teaching and research work carried on at the College Farm more effective.

The Director wishes to thank Prof. John C. Smock for his continued interest in the College Farm. Prof. Smock has been kind enough to present many valuable specimens of trees and shrubs to the College Farm. He has now authorized the purchase, at his expense, of tree labels of attractive design and durable construction. These labels will be used for attaching to the trees and other plantings. In this manner, the students and visitors to the College Farm will be given an opportunity to acquaint themselves with the appearance

and characteristics of the common, as well as the more rare shade and ornamental plantings.

The removal of a large portion of the work of the College and College Station to the Agricultural Building, has made it possible to place additional laboratory and office space at the disposal of the State Chemist. The Nitrogen Room, formerly used by the Soil Department of the College Station, and the laboratory used by the Plant Pathologist are now to be used by the State Chemist. Similarly, two of the offices on the ground floor of Jersey Hall are to be used by the State Chemist and his clerical staff. The Board of Managers of the Experiment Station have placed at the disposal of the Agricultural College such of the rooms in New Jersey Hall as are not at present needed by the Departments of the State Experiment Station. This has made it possible to add to the laboratory space now allotted to the instructors in bacteriology, plant pathology, botany and biology. In view of the courtesies extended by the College to the Experiment Station, both as to the use of land and buildings, it is a source of gratification to the Director of the Station, that these courtesies can be reciprocated, at least, in part.

APPOINTMENTS, TRANSFERS AND RESIGNATIONS.

The following appointments were made within the fiscal year 1913-1914:

Dairy Department—Frank H. Ayres, Helper; Harold A. Yerkes, Assistant Herdsman; Arthur J. Yunker, Assistant Herdsman; John W. Bartlett, Assistant Herdsman, and Frank C. Ashbolt, Assistant Herdsman.

Extension Department—Charles M. Arthur, Specialist in Market Methods; Victor G. Aubry, Specialist in Poultry Husbandry; M. Anna Hauser, Specialist in Home Economics, and Warren W. Oley, Specialist in Horticulture. Mr. Oley was transferred to this Department.

Fertilizer and Feeding Stuffs Control—Herbert P. Rood, Sampler, and Arthur N. Hutchinson, Assistant Chemist.

Entomology—Charles S. Beckwith, Field Assistant.

Poultry Department—Elmer H. Wene, Helper, and Kathryn L. Reed, Stenographer.

The following resignations are noted:—

Dairy Department—Wm. J. Webster, Helpher; John Ryjacek, Helper; Frank H. Ayres, Helper, Harold A. Yerkes, Assistant Herdsman; Arthur J. Yunker, Assistant Herdsman.

Extension Department—Ward C. Pelton, Specialist in Vegetable Gardening.

Fertilizer and Feeding Stuffs Control—Glenn L. Pyle, Assistant Chemist.

Entomology—Joseph S. Obecny, Field Assistant.

Poultry Department—Morris A. Halprin, Helper.

BULLETINS AND CIRCULARS ISSUED.

The following publications appeared within the fiscal year, November first, 1913, to October thirty-first, 1914:

BULLETINS.

261, Analyses and Valuations of Commercial Fertilizers and Ground Bone; 262, Analyses of Materials Sold as Insecticides and Fungicides; 263, Report of the Director, 1912-1913; 264, Fertilizer Registrations; 265, The Ash and Protein Factor in Poultry Feeding; 266, Results of Seed Inspection—1913; 267, Comparison of Magnesian and Non-Magnesian Limestone in Rotation Experiments; 268, Nitrogen Utilization in Field and Cylinder Experiments, 269 Methods and Results in Vegetation Experiments; 270, Ammonification Studies with Soil Fungi; 271, Concentrated Feeding Stuffs and Registrations for 1914, 272, Analyses and Valuations of Commercial Fertilisers, Fertiliser Supplies and Home Mixtures.

CIRCULARS.

29, Peach Leaf-Curl; 30, Apple-Growing in New Jersey; 31, The Establishment of an Apple Orchard; 32, Diversified Poultry Farming; 33, Potato Diseases in New Jersey; 34 Crown Gall and Hairy Root; 35, Some Diseases of Nursery Stock; 36, Grain Smuts: Their Causes and Treatments; 37, The Typhoid Fly and its Associates; 38, Advanced Registry Tests in New Jersey; 39, Poultry Rations and Methods of Feeding; 40, Hog Cholera and Swine Production.

REPORTS.

34 1913—Thirty-fourth Annual Report New Jersey State Agricultural Experiment Station, and Twenty-seventh Annual Report New Jersey Agricultural College Experiment Staton.

SUMMARIES OF THE WORK OF THE SEVERAL DEPARTMENTS.

Following is a series of statements submitted by the heads of the several departments and containing an account of the activities of these departments during the year 1913-1914.

Chemistry.

The activities of the Chemistry Department were, in the present fiscal year, confined almost exclusively to the enforcement of our inspection laws.

In addition to the inspection work, the department has devoted some time to the study of chemical methods and, also, to securing information in order that the Control Officials may make definitions for cottonseed meal. This has involved much work, but has been done in a good cause, inasmuch as the definitions, at the present time, for cottonseed meal and the allied products are rather indefinite.

The regular work of the department has consisted of the following number of registrations:

Fertilizer Registrations,	2,150
Feed Registrations,	1,874
Insecticide Registrations,	167
Lime Registrations,	61
Total number of reports issued,	3,650
Number of letters, dictated and circular,	7,056

The above figures furnish an approximate estimate of the work that has been involved in the carrying out of the various inspections enumerated.

Fertilizer and lime samples received during present year,	1,483
Samples analyzed,	1,023
Total number of determinations, approximate,	12,760

The fertilizer tonnage reports for April showed the following tonnage sold:

Mixed goods,	78,768.27 tons
Fertilizer materials,	8,735.62 tons
Total,	87,503.89 tons

The second reports are due on November 1st.

Number of feeding stuff samples received,	907
Number of samples analyzed,	740
Total number of determinations, approximate,	4,440

The tonnage reports, which were received on July 1, 1913, and January 1, 1914, show that .96,224 tons of feeding stuffs were sold during the year 1913.

Insecticide samples received, ...	91
Samples analyzed, ...	66
Number of determinations, approximate, ...	500

All told, the department has made approximately 17,700 determinations during the past year.

Horticulture.

The two principal features of the Horticultural investigational work are experiments with peaches and experiments on the growing of roses and carnations in the greenhouse.

A heavy crop of peaches was harvested throughout the State during the past year, and special attention was given to demonstrations in packing and shipping in various parts of the State. The assignment of Mr. A. J. Farley to extension work enabled the division to demonstrate the results of investigations with peaches at the request of many growers.

During the latter part of August the Station co-operated with the Vineland Peach Growers' Association and shipped three carloads of peaches to the Boston markets. The Horticulturist assumed full charge of these cars and made some experiments in pre-cooling fruit. Mr. A. J. Farley was sent to the Boston markets to note the condition of the fruit upon arrival.

The fertilizer plots at the Vineland orchard continue to give results for tabulation and study. During the past season the orchard planted in the spring of 1912 came into bearing, giving the Station about thirty additional varieties for study, and the Station now has a rather complete list of descriptions of varieties of peaches with notes as to their behavior under various weather and cultural conditions.

The pruning experiment with peaches which was started in 1912, has produced data of much importance. This will be tabulated and published as soon as the funds are available.

The rose and carnation investigations which have been conducted for several years, have been continued during the year. Some studies of the humidity factor in the culture of roses have definitely shown that this is an important question with commercial florists.

The lime studies with roses have shown that burned and slaked magnesian lime may cause serious damage to roses. A study of different soil types for roses has shown that some roses are very susceptible to changes in soil texture, while others will succeed on a rather wide range of soil types. The variety "My Maryland" has shown aversion to muck soil types.

The plant breeding work with carnations has also made progress. Some minor investigations are being conducted with apples and pears and small fruits. The establishment of a general extension division has

greatly increased the correspondence and field service of the department.

Some investigational work with market crops was undertaken by the extension specialist in vegetable gardening, Mr. W. C. Pelton, and a study of the different varieties af beets was made at the College Farm. Since September 1st the extension work in fruit growing has been placed in charge of Mr. W. W. Oley. The weather records at the College Farm have been continued during the past year with Mr. E. C. Stillwell as observer.

Animal Husbandry.

The Animal Husbandman of the Station confined the investigational work of the year to a study of the comparative cost and value of selected forage crops for swine feeding. A study was made likewise of the resistance of swine to hog cholera and other diseases as influenced by the open range on the one hand and confinement in pens on the other. Digester tankage and alfalfa were used successfully in devising systems of economical swine feeding. The data obtained under the conditions existing at the College Farm indicate that pork may be produced economically even on high-priced eastern lands. These data may be used as a basis for advice to farmers in New Jersey and elsewhere.

The investigations carried on by the Animal Husbandman of the Station have also furnished data of considerable interest on breeding practices, especially from the standpoint of inbreeding and crossbreeding.

Poultry Husbandry.

The work of the Department of Poultry Husbandry during the past year has been very gratifying, especially from two standpoints: namely, the increase in the amount and quality of the research work and the progress made towards equipping the new poultry farm. Four experiments in the nutrition of poultry are now under way. They deal, respectively, with sour milk and its application to chick feeding and feeding for egg production; the quality and amount of meat scrap in rations for poultry; the study of the sources of protein from vegetable products as compared with those from animal products: the value of succulence and the source from which it can best be obtained. The results from these to date are very conclusive.

The experiments in breeding for egg production and inheritance of color pattern are progressing satisfactorily. Within the year many high fecundity cockerels of the White Leghorn breed were reared to maturity and disseminated at a nominal cost to poultrymen throughout the State. The two generations of cross bred birds, resulting from reciprocal crosses of Black Langshans and White Leghorns have just reached maturity. This work, which has been in progress for two years, has given us many facts of interest pertaining to the inheritance of the barring factor and

the inheritance of the color of egg shell. The results also throw some light on the mode of inheritance of black pigment as it occurs in shank color, eye color and plumage color. The work in poultry house construction has been continued. The New Jersey Multiple Unit Laying House has been accepted throughout the State and hundreds of them are being built. Many observations and laboratory experiments have been carried on which cover, in a general way, the minor technical points in the management of the poultry flock. The work on poultry diseases has been much more successful than formerly, over 200 diagnostic reports having been made from birds sent into the department from poultrymen all over the State. The cause of the large death rate among young and old birds during July and August, which has been so apparent during the past three summers, has been determined. It has been found to be due to decayed flesh which, when allowed to accumulate about the plant, develops ptomaines and injurious putrefactive bacteria which cause a high mortality among birds that have access to such material.

The extension work of the department has been enlarged. The publication of the monthly Hints to Poultrymen has been continued. Three new local poultry associations have been formed. All associations in the State have been developed into a strong federation. Many lectures have been given by members of the staff before poultry associations and other agricultural organizations. The correspondence of the department has reached 6,000 letters. To facilitate the correspondence work, many blue prints have been prepared of poultry houses and disseminated at a slight cost to those requesting them. The co-operative experiments which include the keeping of records of various poultry plants has been continued with even better results. Boys' and Girls' Poultry Raising contests have been organized in one county. This work bids fair to increase materially next year. The advisory work of the department has made almost startling growth. The demand for visits by the members of the department for the purpose of helping to plan buildings and equipment, or of advising in regard to methods of management, has been so great that it has been impossible to meet the requests in all cases. Everywhere the work of the poultry department has met with the best of support and co-operation on the part of the New Jersey poultrymen. The work on the new poultry plant is progressing satisfactorily. After the first of November it can be pushed to a rapid partial completion. From $10,000 to $12,000 in additional appropriations will be needed to put the plant in complete and running condition.

Dairy Husbandry.

The work of this Department has been continued along the same lines as in the fiscal year 1913, and may be briefly outlined as follows:

1. Feeding Experiments.

(a) Comparison of Soiling Crops with Alfalfa Hay as an economical feed for dairy cows during the summer months. The total production from six (6) cows on the Alfalfa Hay ration during 50 days was 10,960 pounds milk and 358 pounds butterfat, as compared with a production of 11,097 pounds milk and 364 pounds fat on the Soiling Crop ration.

(b) *Comparison of Soiling Crops with Silage* as an economical feed for growing calves and heifers during the summer months. Average daily gain in weight per calf on Soiling Crop ration was 1.32 pounds per day, as compared with 1.33 pounds when a Silage ration was fed.

2. Herd Records of Production, and Cost of Raising Calves.

Complete records of production, feed, and cost of production have been continued for each individual in the dairy herd, and in addition to the records of milch cows, a complete record has been kept of the feed fed, and the gains in weight of all calves that have been dropped during the fiscal year. A careful study is being made of the relation of feed fed to the gains in weight of calves and heifers.

3. Cow Testing Association Work.

The two Cow Testing Associations organized in 1913 have been reorganized for another year, and one new Association in Salem County has been organized and began work in June. This Department has given assistance to the Sussex County Association in totaling its records for the fiscal year, and has included data accumulated from this Association in this report. Lectures have been given upon this work at institutes and other meetings, and at present there are several communities desiring the organization of these associations as soon as possible.

4. Advanced Registry Work.

Advanced registry work is being done with six dairy breeds as follows:—Holstein, Guernsey, Jersey, Ayrshire, Dutch Belted, Brown Swiss The records of production, feed fed and cost of production of all cows on advanced registry test are continued in this report for the fiscal year 1913–14.

Seed Control.

The work of the Seed Laboratory during the present fiscal year has, essentially, been very similar in nature to that of the previous year. The most notable difference has been in the increased demand for service from individuals throughout the State, indicating that the Laboratory is coming to be recognized as a useful unit in the Experiment Station. Also a large number of official samples has been secured from dealers, and new territory has been reached.

A bulletin (N. J. Agricultural Experiment Station Bulletin 266) giving the results of the analysis of official samples for the previous year, together with other information concerning the work of the laboratory, has been issued during the year. A similar bulletin is in preparation for the present year's samples and will be published as soon as possible.

A collection of samples of lawn grass mixtures has been made and the results of the laboratory tests will be published in the near future. This class of goods is exceedingly variable in contents and in many cases the varieties included have no relation whatever to the establishment of a desirable lawn.

Weed problems in different parts of the State have received considerable attention and, where possible, methods of eradication have been advised.

Through the farmers' institutes, in circular letters to the local trade, and in items in the weekly news letters, an attempt has been made to emphasize the value of the service that can be rendered if the individuals concerned will but take advantage of the opportunity offered for their protection.

In the arrest and conviction of Mr. O. J. Rice, brought about largely through the efforts of this department, it is believed that considerable has been gained to the farmers of the State in the matter of protection from fraudulent agents or dealers who find the farmers their special prey.

Realizing the value of the acclimated varieties in the successful production of alfalfa, twenty strains of seed have been secured from various sources and distributed in five counties of the State. It is hoped that among these there will be strains or individuals which give promise of superiority under local conditions and from such it is intended to secure seed and to further extend the work as developing conditions demand.

Special problems relating to the testing of certain seeds have been attempted, but as yet are not sufficiently advanced to be reported upon.

Agricultural Extension.

The purpose of the Extension Department is to aid in diffusing among the people of New Jersey useful and practical information on subjects relating to agriculture and home economics. The chief source of this information is the experiment stations of New Jersey and other states. The plan is to carry truth of practical value to the people and to do so in the most effective ways possible.

Demonstration is our most important method. People accept truth most readily when they are given ocular demonstration. To this end we have in our department one specialist in agronomy; one in horticulture; one in market gardening; one in poultry husbandry; one in marketing, and one in home economics. In addition to this force of specialists we have four county superintendents of farm demonstration, and three other counties have provided funds for beginning work this fall or winter. The specialists in the department render direct service to organized counties through the county superintendent of farm demonstration and they serve other counties upon requests of various associations and individuals.

The specialist in agronomy is conducting field demonstrations to determine the value of the various strains of corn grown in New Jersey. He is also conducting experiments in the top dressing of grass lands, with valuable results. Work is also being done to determine the most valuable varieties of soy beans, and interest in cover crops is being aroused.

The specialist in horticulture has been nearly overwhelmed with requests for pruning and spraying demonstrations, and counsel regarding the treatment of orchards.

The specialist in market gardening has begun co-operative work with tomatoes, lima beans and cabbages, and his work in connection with school-gardening has met a hearty response.

The specialist in poultry husbandry has continued in the effective extension work that is a considerable part of the work of the Poultry Department, giving advice to thousands of poultrymen of the State.

The specialist in markets began work September 1st and has given his time largely to a survey of market conditions. In connection with his

work he is preparing a weekly news-letter for the papers circulating in New Jersey.

The specialist in home economics began work September 1st and there was immediate demand for demonstrations and lectures related to home economics. Our county superintendents of farm demonstration and women's clubs want her services. Her line of work includes all phases of home economics.

Mr. A. L. Clark, Assistant State Leader, has immediate oversight of county demonstration work. Thoroughness in extension work will demand the appointment of a county superintendent of farm demonstration in every agricultural county of the State. Mercer and Sussex Counties were organized previous to the beginning of the fiscal year. During the year Bergen and Monmouth Counties have been organized. Atlantic County has made appropriation and Mr. Elwood Douglass, of Cold Spring, N. J., will begin the work in Atlantic County November 1st. Burlington County has made the proper appropriation and it is hoped that a county demonstrator may be on the ground December 1st, Cape May County has made appropriation and it is hoped that the right man for the position will be found by January 1st.

Other counties are signing petitions for the appointment of a county superintendent and progress along this line is checked only by difficulty in finding men competent to be representatives of the Experiment Station in all of these counties. The men now engaged in county demonstration work are rendering excellent service, having the support and co-operation of the local people.

While demonstration is a leading feature of our extension work, the demand for information through addresses and correspondence grows greater each year. The members of the extension staff are making replies to many thousands of inquiries by letter and are meeting requests for addresses that come from county superintendents of public schools, county Y. M. C. A. secretaries and the hundreds of organizations of practical farmers throughout the State. Great numbers of requests for visits to farms come to the department and only a fraction of such requests can be met.

The limited appropriation by the State for demonstration work, supplemented by the Smith-Lever appropriation, takes care of the demonstration work carried on by our specialists and has permitted a small appropriation direct to the support of the county work, but it does not enable us to meet the State's demands in any such degree as is found possible in adjoining states. The county superintendent of farm demonstration is the representative of the Station within the county, and the State should contribute at least $600 to the expenses of such work in each county, supplementing a similar appropriation by the Bureau of Plant Industry. Several more specialists are needed within the department to make the work of county demonstration fully effective and to meet the demand for service from unorganized counties. A much larger number of circulars giving practical information to inquirers should be published, and reports from associations of farmers for addresses on practical farm

topics should not be denied through lack of a sufficient staff of men. It is hoped that the next legislature will appropriate liberally for demonstration and extension work and that the appropriation in any event will not be less than $25,000.

Farm Crops.

Aside from problems relating to the maintenance of the College Farm grounds, roads and buildings, which have taken up a large portion of the time of the Farm Manager, a study has been made in the Department of Farm Crops of cost of growing alfalfa, soy beans, corn and other crops. This department is endeavoring to determine whether it is feasible to raise maximum yields of roughage and at least a portion of the concentrates on a relatively limited area of land for the maintenance of the dairy herd of the College and Station. Alfalfa has continued to give very gratifying returns and the results of the season of 1913 confirm those of earlier seasons and show that it is practically indispensable for the economical production of market milk. A careful record has been kept of the cost of securing a stand of alfalfa and also of the cost of harvesting, curing and storing this crop. Data on the cost of producing and storing soy beans, rye straw and timothy hay have also been secured and recorded. These are contained in the report of the department.

Soil Chemistry and Bacteriology.

The work of the Soil Department has been continued along the lines set forth in the reports for the past few years. This work naturally divides itself into (1) Cylinder Experiments, (2) Pot Experiments, (3) Field Experiments and (4) Laboratory Experiments.

Cylinder Experiments.

The cylinder experiments are planned witb the idea of condensing a large amount of work in a small space and also with tbe idea of more exact control than is possible in field experiments. Three hundred and twenty of these cylinders are employed in making a comparative test of the availability of nitrogen in the form of nitrate of soda, green manure crops and stable manure. This work, which was begun in 1907, is being carried out on eight different types of soil and is so planned that a complete four-year rotation can be grown on each type every year. The work of the past year has been quite successful. The green manure crops have given especially good results. Soy beans are now being grown where cow peas were formerly used for tbe reason that, after a few seasons, the cow peas do not do well. The vetch has also made an excellent growth during the past summer and fall. The work has clearly demonstrated that it is possible with green manure crops, which may be grown without interfering with the regular crops of the rotation, to keep the nitrogen supply of the soil at as high a level as with stable manure at the rate of fifteen tons per acre once in two years, and, at the same time, secure a larger yield of dry matter.

The loam soil cylinders, sixty in number, which have been under observation since 1898, have also given excellent results. Here again the influence of the green manure crop has been very pronounced. With the oats crop, and also with the residual corn crop, the yield of dry matter was approximately double what it was on the cylinders otherwise similarly treated but having no green manure crop. Through the use of manure and green manure, the physical condition of the soil has been notably improved.

In the dilution cylinders, also sixty in number, the percentage of nitrogen recovered continues higher with the nitrate of soda than with the dried blood except with those cylinders which contain eighty to one hundred per cent. sand.

Pot Experiments.

During the winter about ten series of pot experiments were conducted in the greenhouse. Part of these were lime experiments and part were planned to throw further light on the cause of the depressed yield of dry matter in the presence of large amounts of carbo-hydrates.

During the past summer, further pot experiments were conducted along the lines mentioned above, and also a number of experiments to determine the effect of various factors upon the protein content of soy beans, as, for example, thickness of planting, date of harvesting, mineral fertilizers and soil amendments used, the protein content of the different varieties, etc. Tests were made of the effectiveness of different inoculating materials with soy beans, cow peas and crimson clover.

Other experiments, both field and pot, were conducted to determine whether or not there is in the material known as "American Rock Potash," said to be prepared from feldspar, a compound that is toxic to plants. Experiments were also conducted to determine whether or not a mineral material which is sold under the name of "B. D. R." and said to be a by-product in the manufacture of radium, has a stimulating effect upon plant growth.

Field Experiments...

Field experiments have been conducted along lines laid down in previous reports and bulletins. These involve availability tests of different nitrogenous materials with and without lime; a comparison of magnesian and non-magnesian limestone in rotation experiments; the continuous growing of wheat and rye with and without a leguminous crop; the continuous growing of corn wtih a leguminous and non-leguminous green manure crop, and certain other experiments looking toward a bacteriological study of soils receiving different treatments. Also variety tests with soy beans have been conducted and tests to determine the effect of lime with soy beans. The field work has been conducted in a very satisfactory manner and the crops have practically all been harvested.

Laboratory Experiments.

Many experiments were conducted in the laboratory with a view to determining the most favorable conditions for ammonification. This work led to the confirmation of work done by Muntz and Coudon as early as 1893, showing that soil fungi are able to ammonify soil organic matter. In connection with this work, it was further noted that in a number of cases the presence of considerable quantities of acid phosphate in the soil stimulated the ammonifying powers of the fungi. On the other hand, large applications of acid phosphate caused a rapid decrease in the number of bacteria present in the soil. The work further showed that certain fungi have a greater ammonifying efficiency than others and also that certain fungi have greater ammonifying efficiency than some bacteria.

As in previous years, between two and three thousand nitrogen determinations have been made in connection with field, pot and cylinder experiments, and considerable miscellaneous work has received attention.

A large number of soil samples has been collected from the Monmouth Area in connection with the State Soil Survey and it is expected that these will be analyzed during the coming year. Samples have again been collected from a large proportion of the field plots for determining the lime requirement.

Equipment and Improvements.

A new greenhouse on the College Farm, which is now practically complete, will give additional space and afford better accommodations for the pot work, and, in addition, place this work near the soil house and wire cage where the summer work is conducted. The laboratories in the new Agricultural Building, with new and enlarged equipment, will make it possible to prosecute the work in a more effective way than has been done in the past. During the year there has been added considerable new laboratory equipment, which will also increase the effectiveness of the work of the Department.

Biology.

The work of the Biological Department has been confined to studies of oyster propagation at Barnegat and at Tuckerton. The assistant in charge of the Barnegat Station was John N. Lowe, Ph. D., instructor in the University of Wisconsin. The placing of a man of such high qualifications in the position was a step in decided advance upon our practice in previous years. The results obtained were of a greatly improved character both in quantity and quality, and more than justified the slight increase in the cost of maintenance. At Tuckerton the services of the chief assistant, T. C. Nelson, were available for only one month, as he was called by the National Bureau of Fisheries to investigate oysters in Alabama waters. There seems to be an increasing demand in connection with the oyster industry for competent men who are willing to engage in this field of practical research, logically a branch of that field

of Agriculture known as Animal Industry. The Station Biologist was called by the Biological Board of Canada to study the oyster situation in Prince Edward Island and to give advice to the people who find it necessary now to advance this industry from the condition of a fishery to that of scientific oyster farming. This service was rendered by the Biologist during the last week of August and the first week in September when the demands of his own work in this State were the least pressing.

The weather conditions of the past season offered natural experimental conditions of any unusual kind that threw much light on the obscure phenomena of oyster propagation. In general the effects of these conditions were to delay the set of "seed" or "spat" and to restrict its abundance and vitality. Except in limited areas of our North Atlantic Coast there was no appreciable "set" of spat until late in July or even the middle of August and of this there was a greater proportionate loss by death than usual. While it is an open question whether or not the extra loss was due to unusual causes operating on the spat itself, the Biologist is inclined to attribute it to the effects of low July temperature upon the eggs while they were in the oyster. It is again emphasized that research in this field is prosecuted under peculiar difficulties, and great patience and persistence are required to get an understanding of the forces involved.

Steps have been taken to replace the oyster exhibits prepared for the Columbian Exposition in 1893 which were destroyed by fire in Jersey Hall in 1903. To this end a room in the basement of Jersey Hall has been provided with cases for the nucleus of a new ostracultural museum. Such an exhibit will be instructive not only to the public, both lay and professional, but will be a great aid to the Biologist and his assistants in objectifying the results of our investigations. This work is constantly broadening and new vistas are opening up. It is to be deplored that under these circumstances there has developed an effort to lessen the present modest appropriation for "Scientific Investigation of Oyster Propagation." *The fact that the oyster industry is worth four or five million dollars annually to the people of this State should be sufficient reason for treating this branch of Agriculture with the proportionate consideration that is its due.*

Botany.

The work for the past year has been along the following lines: (1) Heredity; (2) Toxicology; (3) Sap-circulation; (4) Environment; the major part of the funds being expended in the first named project.

The leading subjects employed were tomatoes, peppers, corn, beans, eggplants, okra and soy beans. Fully 5,000 plants of crossed tomato plants and 3,000 of crossed peppers were grown upon the four acres of the breeding grounds; nine blocks of corn and several plots of prairieberry, eggplant, beans, soy beans, etc., also received a place and attention.

The season was not good for the growth of such crops, particularly those from seedlings from the greenhouse, which suffered greatly from the backward spring and the prolonged drought of autumn.

With the tomatoes, the results show that many intermediate shapes and sizes breed true, and these characters are determined by the interaction of a few factors for shape and size and not by a multitude of factors for specific shapes and sizes. The peppers have shown that, while their crosses are fairly constant in the first generation (F), they may produce several types in the F_2, and these later may become fixed by isolation. They have further shown that there may be great differences between the reciprocal crosses particularly in degree of fruitfulness, so that it seems necessary to cross both ways before the full value between two kinds in breeding can be determined.

With corn it has been shown that in crosses between flinty and floury types of grain the floury behaves somewhat like a Mendelian recessive. It was also shown that the F_1 plants of extreme crosses showed a strong tendency to adhere to one or the other parental type in length of season, size of plant, ear, grain, etc. It has been shown that prolificness is a character that is governed somewhat by heredity and it may be of most importance to eliminate even the partially barren plants, as for example the earless stalks of corn before they bloom.

After six generations of selection, it has heen shown that the seed-cavity number in the prairieberry, though fluctuating from 2 to 13, could not be permanently increased. It has been shown that the position of the seed in the pod has an influence upon the viability of the seed and the vigor of their seedlings, as, for example, the middle seeds of the pea pods are superior to those at either end. In like manner the largest and best grains of corn are borne somewhat above the butt and are the first to begin forming upon the cob.

In the study of the hypocotyl of beans, a correlation is apparent between the variability in its length and that of the first internode, suggesting that variability in one structure may be linked with that of another.

When planted in soil sufficiently poisonous to the roots to allow initial growth only, the sweet potato is able to deposit the starch, otherwise going to the roots, in the basal part of the plant.

Entomology.

The attention of the Entomologist has this year been devoted (1) to carrying on a correspondence involving 8,000 letters for the purpose of furnishing information needed by the people of the State in protecting themselves and their crops and animals against injurious insects; (2) to helping by means of circulars, letters and press articles, personal visits and law enforcement, those who seemed particularly to need assistance (among the pests that occasioned complaint may be mentioned fleas, bed bugs, apple plant lice, grape leaf hopper, American tent caterpillar, army worm, corn ear worm, rose beetle, June bugs and white grubs, strawberry

weevil, potato flea beetle, flies and mosquitoes); (3) to the investigations of peach tree coatings for protecting them from borer attack, the effect of dusting and spraying on white potato foliage and yield, the problems of fly control, and the problems of mosquito control; (4) to the carrying on of salt marsh drainage and to extending aid to Boards of Health in their efforts to control the mosquito pest; (5) to general oversight of and supplementing the work of the county mosquito extermination commissions.

Some Points in the Work of Insect Control.

The season opened with an outbreak of the American tent caterpillar, which defoliated the wild cherry over waste lands throughout the northeastern part of the State. After consuming the leaves of the plants to their liking, those worms that were not yet mature made their way into yards and gardens and defoliated apple, pear and peach, and destroyed many kinds of garden vegetables. Letters, personal visits, lectures and newspaper articles were used to help the persons troubled. In late June the army worm began in Monmouth County to migrate from grass lands into potatoes, corn, and wheat. Early in July the same species were found to be injuring lawns throughout the towns and cities of the State. Lawns were in many insrances so badly eaten as to turn brown. In many cases the worms could not find enough food to finish their growth and, assuming the army habit, made their way into neighboring gardens and fields. Letters, press circulars, and personal demonstration work were resorted to. In early September a small outbreak of this species appeared at Fairton in Cumberland County and along the shore in Monmouth County. At no point, however, were the numbers sufficient to do any considerable amount of damage.

As the wheat began to ripen it became evident that a large amount of damage would be chargeable to the Hessian fly. The damage was general throughout the wheat growing districts, but seemed worst in the western part of the State between Trenton and Belvidere. In some places the damage was estimated at 75 per cent. of the total crop. Nothing could be done to reduce the damage to crops already infested, but measures of preventing harm to next year's crops were distributed.

In June the May beetles appeared more abundantly than for many years and the tender leaves of forest, shade and fruit trees were badly eaten. Their feeding at night only and the consequent failure of people to see them led to much speculation as to the cause of the injury. Whether the extraordinary numbers of the beetles mean a very large brood of white grubs (which are the immature stage of the May beetles) and correspondingly greater damage is a matter that only time can tell. A close watch will be kept and proper warning issued should such damage threaten.

The enforcement of law against the harboring of insect pests was employed to free persons, who were trying to grow clean fruit, from infestation from neighboring neglected plantings. In his capacity of State Entomologist of the Board of Agriculture, the Entomologist ordered the

abatement of certain such nuisances and saw that the directions were carried out.

The interest in fly control is great and growing. Boards of Health and individuals sought aid in the planning of anti-fly campaigns.

From the standpoint of the conditions that favor salt marsh mosquito breeding the present season has been the most favorable for many years. The Entomologist was engaged constantly in answering calls for assistance from the time the mosquito breeding conditions became unusual for a period of about eight weeks.

INVESTIGATION WORK.

Peach Borer.

The investigation of the peach borer problem consists in the tests of various practicable tree-trunk-coating substances as a means of protecting the trees from attack by the borer. The investigations have not yet gone far enough to admit any really definite statement. Suffice it to say that certain substances (whitewash and asphaltum) look promising, but must have further test.

Spraying and Dusting of Potato Foliage.

The study of the effect of dusting and spraying mixtures on the foliage and yield of white potatoes is a continuance and enlargement of that undertaken last year. This year we were fortunate enough to have the services of Mr. A. E. Cameron, whose entire attention could be devoted to the work. Experiments were undertaken in three places—on the farm of J. Harry Kandle at Elmer in Salem County, on the farm of Robert M. Dilatush at Robbinsville in Mercer County, and on the farm of Frank P. Jones at Freehold in Monmouth County. At Elmer about eleven acres were involved in the test; at Freehold about twenty-five, and at Robbinsville about twenty-four. The results secured are discussed elsewhere in this report.

Flies.

The attempt to control the flies on the College Farm during the past season has brought out certain problems that needed further investigation—the species of flies with which the control agency has to deal and the relative importance of each, the sources of flies which are present after all breeding places have apparently been eliminated, the nature of an effective bait, the substances that are practicable and effective larvicides. Data have been accumulated on all these points but the study shows clearly that further investigations are needed before any place can be rendered flyless.

Mosquitoes.

The investigation of problems connected with mosquito control has clearly shown that with a combination of long continued extreme high tide, considerable rainfall, and much cloudy weather the drainage systems

at present installed in shut-in salt marshes will prove insufficient to prevent mosquitoes from breeding on them. It is evident that either larger outlets must be provided, or the tide must not be allowed to penetrate them. The former is usually not practicable for it involves the cutting of important railway and roadway grades. The latter alternative is likely to prove much simpler. The railways or roadways that shut the meadow in will usually serve as a dike and merely the sluice and gates must be installed. The ditching already in the meadows will serve to collect the water and to lead it to the sluice ways. When the marsh is penetrated by open sewers, it is well to bank their sides and leave their flow unimpeded by tide gates. To tide gate them is to cause the matter which they carry in suspension to fall and render frequent cleaning of their channels necessary.

The sewage charged salt marsh is area for area the most prolific breeder of mosquitoes that we know. Not only do the salt marsh species breed in such places very abundantly but the house mosquito, an insect which because of its house penetrating ability is far more annoying than any salt marsh species, is produced in immense numbers and makes its way over adjacent upland for a distance of 2.5 miles or more.

The investigations have shown that with long continued high tides, rainfall and cloudy weather, some breeding will occur on drained marshes that are not shut-in, and that much breeding would surely occur if the killifish did not consume it. The present drainage on the open meadow prevents the breeding of mosquitoes not only by carrying off the water but by rendering all parts of the marshes readily accessible to the killifish. These fish breed in the larger, more permanent pools of the salt marsh and until ditches were cut had to depend upon extra high tides for distribution.

The investigations have shown that, while most of the normal breeding will be prevented by a drainage which is opened up once each year (in the spring after the period of high tides is past), the prevention of the rest *will follow only where the marshes are constantly patrolled throughout* the mosquito-breeding season, and killifish and oil distributed as the case seems to demand.

MOSQUITO CONTROL WORK

In Connection With the Salt Marsh and Local Boards of Health.
Facts Brought Out by the Salt Marsh Inspections.

Salt Marsh in General.

Under the authority of our salt marsh drainage law the whole salt marsh has been kept under general observation and specific parts have been examined as the need of the work dictated. The following general observations may be noted:

1. Mosquitoes found at points between New Brunswick and the park at the Jersey City end of the Newark and Jersey City Plank Road, with the

exception of the few taken along the Paterson Plank Road, were much worn and were members of the early May brood.

2. The mosquitoes found in the above park, at Swift's plant, and in Harrison, came directly from the adjacent shut-in and imperfectly drained marshes.

3. The mosquitoes found in Newark, Elizabeth, Rahway and Sewaren, were of a different species and evidently also came from adjacent shut-in and imperfectly drained marshes.

4. The almost total absence of salt marsh mosquitoes from Perth Amboy to Bay Head can be ascribed to nothing other than to fairly satisfactory drainage systems established in the marshes of that territory.

5. The greater number of mosquitoes found near Browns Mills must be attributed to migrations from the Mullica River marshes.

6. The moderate increase in mosquitoes from Lakehurst south to Barnegat must be attributed to less satisfactory drainage of the marshes along the Bay and to its proximity to the undrained marshes below Manahawkin.

7. The comparatively small number of mosquitoes taken between Jersey City and West Creek must be attributed to the more or less perfect marsh drainage that has been established, for no sooner did we pass from territory adjacent to the drained marsh into territory adjacent to the undrained marsh (which we did between Barnegat and West Creek) than the mosquitoes collected increased many times in number. Nor does the number collected tell the full truth, for the mosquitoes were so thick that less than five minutes were spent in collecting. Their blood thirstiness was too great to be borne.

8. The thinning out in the number collected in Atlantic County occurred in territory adjacent to drained marshes.

The sewage charged marshes of Newark Bay and the Hackensack River Valley were again troublesome, producing house mosquitoes as well as salt marsh species that spread out over adjacent upland.

Hackensack Valley Salt Marsh.

The repeated salt marsh mosquito broods that last year came into northeastern Essex, southern Bergen and Passaic Counties from the Hackensack Valley indicated clearly that this marsh bred mosquitoes in parts where they were not thought to develop and an effort was made to provide for its regular inspection throughout the season.

Beginning on April 13, corps of inspectors, composed of men from Essex, Union and Hudson Counties, headed by Mr. William Walden and Mr. Henry H. Brehme, made a thorough inspection of the entire Hackensack Valley salt marsh of about 19,000 acres, requiring one month to complete the work. Mr. Walden set forth the results in a formal report. At the end of this period Mr. Walden returned to Essex County and the Hudson Inspectors to Hudson County. Mr. Brehme was given charge of the corps and covered the valley every ten days or two weeks thereafter throughout the mosquito breeding season.

The results of each covering were set forth in a map and accompanying reports.

This inspection has demonstrated that all parts of the marsh breed under favorable conditions and the drainage of the entire area must be considered. Drainage maps and plans are now in process of preparation.

Drainage Work.

The principal ditching was done in Atlantic County where the county itself was expending considerable sums of money on the salt marsh, and was placed in the marshes of Patcong Creek and Great Egg Harbor River. All told, not counting advertising, cost of mapping and oversight of the work, $5,876.86 have been expended for the cutting of 271,500 feet, relieving approximately 4,000 acres.

In addition, the Experiment Station has paid one-third the cost of cleaning and rendering Franck's Creek, the sole outlet of several hundred acres of Kearny meadows, and one-half the cost of certain additional drainage on the Union County section of the Newark Bay Meadow. This last area had been ditched some years ago but the outlets were inadequate. It was for the purpose of demonstrating the remedy that should be applied that the Station agreed to pay a part of the bill.

Boards of Health.

Numerous calls from Boards of Health for aid in mosquito extermination work have been answered and such aid as was within our power furnished.

In Connection with County Mosquito Extermination Commissions.

Much of the time of the Entomologist has been given to the work of aiding the efforts of the different county mosquito extermination commissions. The commissions that have had some experience in the work of mosquito control have this year found new problems and commissions just taking up the work required constantly more or less help. In the course of this work, at least sixty set appointments ranging from one-half to two days have been fulfilled, not to mention the incidental correspondence and more or less formal reports of findings and recommendations. In general, although like everything else the county mosquito extermination commission has its failures, it is the most efficient agent for control of local mosquito breeding yet devised. Its work has been of such a character as to justify its continuance and further trial.

During the present year four counties have had the work going on over all territory within their limits—Atlantic, Essex, Hudson and Union. Four counties have undertaken demonstration work in limited localities—Camden, Bergen, Middlesex and Passaic.

Plant Pathology.

The study of the relation of tannin to the Chestnut bark disease (Endothia parasitica) was completed July 1st and Mr. Wilson's duties discontinued. The result will be published in the annual report.

The potato investigations consisted of (1) Mr. Lint's work on the influence of sulphur on potato scab, a resumé of which as appended to this report and (2) to dusting and spraying experiments in co-operation with the Department of Entomology and the Union Sulphur Company. The field tests were conducted by Mr. A. E. Cameron, of the Department of Entomology, and the results are given in the report of that Department.

The apple orchard investigations, in co-operation with the Department of Entomology and the Union Sulphur Company, were carried on by Mr. Martin of this Department, and were restricted to the use of sulphur for the control of fungous diseases and insects, as compared with the recognized standard treatments which are in general use. A resumé of this work is appended to this report.

The Department has also given some attention to the Jonathan spot rot, the results of which are also appended to this report. The pear orchard investigations were carried on by Mr. Martin, of this Department, and were for the purpose of determining the most profitable methods of controlling the leaf and fruit spot fungi. The results of this work are appended to this report. A study of the peach "yellows" and "little peach" were conducted primarily by Mr. Schwarze and will be the subject of a bulletin in the near future. The study of the crown gall in the nurseries will be continued. It is impossible to make a report at this time. The investigations on diseases of sweet potatoes and cranberries were discontinued for lack of funds.

A survey of the plant diseases of the State to be published under the title of "Parasitic Fungi of New Jersey," is now nearing completion.

Report of the Chemist.

CHARLES S. CATHCART, M. SC.

I. Inspection of Commercial Fertilizers During 1914.
II. Inspection of Agricultural Lime.
III. Inspection of Concentrated Feeding Stuffs.
IV. Inspection of Insecticides.

I.

INSPECTION OF FERTILIZERS DURING THE SEASON OF 1914.

The fertilizer inspection during the past season was made under the authority of the fertilizer law which was approved March 27, 1912. The full text of the law has been quite thoroughly distributed and it is unnecessary to reprint it in full at this time. A brief summary, however, of the requirements as enumerated in the law may be given as follows:—

(1). Prescribes the statements that may be used in branding the materials sold and stipulates that *no others* shall be used. (2). Requires regular brands to be registered with the State Chemist on or before November first of each year. New brands may be registered at any time during the year previous to their sale. (3). On April 1st and November 1st each person engaged in the manufacture and sale of fertilizers shall submit a report showing the tonnage sold since the date of the previous report. (4). The State Chemist is required to publish the registrations made and, also, to sample and analyze every brand found on the market, and to publish at least one bulletin giving the results found. (5). The violations of the law are defined and the penalties stated.

Registrations.

During the year, 138 firms or persons registered the products to be offered for sale by them. In accordance with the requirements of the law, under date of January 14, 1914, the various registrations that had been received were published in Bulletin No. 264, and those that have been received since the date given will be published as a part of Bulletin No. 274.

During the year, 2,150 registrations were made. Eighty-three of these registrations were not made, however, until our inspectors had reported the brands were on the market. Although this is a better showing than reported last year, it must be remembered that it is necessary to attend to the registrations *before* the materials are offered for sale. Some misbranding was found, and in every instance the attention of the manufacturer was called to the necessity of complying with the law.

Reports on Tonnage.

The party registering materials for sale is required to render re-

ports twice a year, April 1st and November 1st, stating the total number of tons sold. The following is a summary of the reports rendered for 1913 and 1914:—

		Tons of Mixed Goods.	Tons of Fertilizer Materials.	Total for the Year.
1913	April	87,146.91	10,303.17	
1913	November	51,706.28	7,204.79	156,661.15
1914	April	78,768.27	8,735.62	
1914	November	59,223.26	8,686.99	155,414.14

Inspection for 1914.

The work of inspection and the collection of samples usually starts about March 1st and our inspectors were prepared to commence the work at this date but were delayed on account of the severe snow-storm. In arranging the itinerary for the inspectors, the southern part of the State is the starting point since the fertilizers are found there earlier in the season than in other sections of the State. As the season advances the shipments are to be found in the other sections. This year, on account of the storm, when the shipments from the factories started they appeared in different sections at the same time, and as a result some confusion was caused by the itinerary which had been prepared. The different sections of the State were carefully looked after, however, and we feel confident that samples of practically all of the different brands were collected.

During the inspection every county in the State was visited, and a total of 1,500 samples was secured in duplicate. These samples represented the stock of 523 dealers and consumers. The results of the inspection, with the exception of a few analyses of unofficial samples of mixed goods which were reported directly to those submitting the samples, were published in Bulletins 272 and 274.

The samples examined and reported are as follows:—

610 samples of commercial fertilizers, 24 samples of commercial fertilizers (duplicate), 32 samples of commercial fertilizers (unofficial), 12 samples of home mixtures, 38 samples of miscellaneous mixtures, 130 samples of fertilizer materials, 43 samples of ground bone, 46 samples of sundry materials, 935 total samples.

The analyses of the above required about 12,760 separate determinations.

Wholesale Prices of the Essential Elements of Plant. Food for 1913.

The wholesale prices of the unmixed or raw materials, used in preparing the mixed fertilizers, are quoted weekly in the trade journal, "The Oil, Paint & Drug Reporter." In order to express the figures given as prices per pound of actual plant-food which is the form adopted by the Experiment Stations of this country, the quotations have been recalculated and tabulated for the entire year. On account of the fact that the report of the Station is made on October 30th of each year, the prices that have been tabulated are for the year 1913.

Wholesale Cost, Per Pound, in New York.

MONTHS 1913.	OF NITROGEN IN FORM OF—			Of Phosphoric Acid in Form of—		OF POTASH IN FORM OF—			
	Nitrate of Soda.	Sulphate of Ammonia.	Dried Blood.	Acid Phosphate.		Kainit.	Muriate of Potash.	Double Sulphate of Potash and Magnesia.	High Grade Sulphate of Potash.
	Min.	Min.	Min.	Min.	Max.	Min.	Min	Min.	Min.
	cts.*	cts.*	cts.*	cts.	cts.	cts.*	cts.*	cts.*	cts.*
January.	16.54	15.91	16.70	2.50	2.75	3.38	3.82	4.81	4.81
February.	16.61	16.10	16.70	2.50	2.75	3.38	3.82	4.81	4.81
March.	16.61	16.10	16.70	2.50	2.75	3.38	3.82	4.81	4.81
April.	16.61	16.10	16.70	2.50	2.75	3.38	3.82	4.81	4.81
May.	16.61	16.10	16.70	2.50	2.75	3.38	3.82	4.81	4.81
June.	16.13	15.37	17.06	2.50	2.75	3.38	3.82	1.81	4.81
July.	15.81	14.88	17.30	2.50	2.75	3.38	3.82	4.81	4.81
August.	14.86	14.39	17.30	2.25	2.50	3.38	3.77	4.81	4.81
September. . . .	14.92	14.68	17.55	2.25	2.50	3.38	3.77	4.81	4.81
October.	15.02	15.12	17.91	2.25	2.50	3.38	3.77	4.81	4.81
November.	14.76	15.04	18.45	2.25	2.50	3.38	3.77	4.81	4.81
December.	14.06	14.39	20.04	2.25	2.50	3.38	3.77	4.81	4.81
Average, 1913. .	15.71	15.35	17.43	2.52		3.38	3.80	4.81	4.81
Average, 1912. .	15.32	16.03	16.69	2.63		3.36	3.80	4.78	4.79
Average, 1911. .	13.87	15.09	19.14	2.88		3.17	3.66	4.57	4.63

*Maximum figures lacking.

Schedule of Trade Values for 1914.

As the manufacturers probably place most of their contracts for raw materials near the close of the year, the quotations for the last four months of 1913 and the first two months of 1914 have been considered as a more suitable basis for the determination of the trade values for 1914.

Taking these wholesale prices as a basis, the following schedule of cents per pound prices of various materials was arranged at a meeting of the Station directors and chemists for use in the New England States and New Jersey during the season of 1914.

Nitrogen in nitrates, 16.5; in ammonium salts, 16.5. Organic nitrogen in fine* ground fish, meat and blood, 22.5; in cotton-seed meal and castor pomace, 22.5; in fine* bone and tankage, 21.5; in mixed fertilizers, 19.5; in coarse* bone and tankage, 17.5. Phosphoric acid, soluble in water,

*** "Fine" signifies such as will pass through a sieve with circular holes 1-50 of an inch in diameter and "coarse" such as will not.**

4.5; soluble in ammonium citrate, 4.0; in fine*-bone and tankage, 4.0; in cotton-seed meal and castor pomace, 4.0; in coarse* bone, tankage and ashes, 3.5; insoluble in water and ammonium citrate, 2.0. Potash in high-grade sulphate, and in forms free from muriate (chlorides), 5.0; in Muriate, 4.0; in cotton-seed meal and castor pomace, 5.0.

Results of the Inspection.

The average amounts of plant-food guaranteed and delivered in the six hundred and ten (610) brands which were reported in Bulletins Nos. 272 and 274 are as follows:—

	Average Found %	%	Average Guaranteed %
Nitrogen as nitrates,	0.44	....	....
" " ammonia salts,	1.02	....	....
" " water soluble organic,	0.40	....	....
" " active insoluble organic,	0.50	....	....
" " inactive insoluble organic,	0.30	....	....
" total,		2.66	2.58
Phosphoric acid, total,	9.24	....	....
" " insoluble,	1.49	....	....
" " available,		7.75	7.44
Potash,		6.91	6.53
Average selling price per ton,			$29.51
" valuation per ton,			22.40
" cost of mixing, bagging, etc., per ton,			7.11

The above tabulation shows that the fertilizers examined on the average contained more actual plant-food than was guaranteed. A study of the individual analyses will show that in order to obtain this average some of the brands exceeded the guarantees, while other brands fell short, some in one element, some in two elements and in a few cases all three elements were deficient.

One hundred and eighty-six brands examined fully satisfied every guarantee given, and 234 brands substantially satisfied the guarantees. There were 63 brands deficient in nitrogen, 92 brands deficient in phosphoric acid and 49 deficient in potash, making a total of 204 deficiencies. The deficiencies were distributed in 188 brands, or 30.8 per cent. of the number examined, 174 being deficient in one element, 12 in two elements and two brands deficient in all three of the elements. Comparing these figures with those reported last year, we find that the results obtained this year show more deficiencies than found in 1913 when 28 per cent. of the brands was found in the deficient class.

There are many problems connected with the fertilizer question which cannot be solved until a careful chemical examination is made of the particular product or the results have been obtained in the field. As it may be impossible to secure the desired information when needed, it is often necessary to depend upon the guaranteed analysis of the fertilizer as well as the reputation of the manufacturer. At the time of purchasing fertilizers the main question, under the present conditions, is in regard to the character of the nitrogen content, since the character of available phosphoric acid and water soluble potash

needs no consideration other than the amount guaranteed and the record of the manufacturer. Knowledge of the character of the nitrogen content is a very important matter, since the guarantee of the total nitrogen is the only information given in the guarantee and it may be derived from nitrate of soda, sulphate ammonia, high grade organic materials, low grade organic materials or a combination of them. The availability of the nitrogen content will, therefore, depend upon the material used in preparing the mixture.

In the brands examined this year, 520 brands contained nitrogen in the form of nitrate or ammonia salts; 208 brands contained nitrate nitrogen; 465 contained ammonia salts and 153 contained both of these forms. There is no question regarding the high availability of nitrogen in either of these forms. The organic nitrogen may be present in three forms, viz.:—water soluble, active insoluble and inactive insoluble.

The water soluble form of organic nitrogen is, undoubtedly, an available form of nitrogen, but the portion that is insoluble in water should be carefully investigated and if the results secured by the method in use in this State, and various other States, show that the active insoluble nitrogen is present in larger proportions than the inactive insoluble, it may be safely assumed that the organic nitrogen is derived entirely, or very largely, from material of good availability. If the inactive insoluble equals or exceeds the active insoluble, the organic nitrogen is derived, in part at least, from an inert material. A study of the detailed analyses will show that 140 of the brands examined contained an inert form of nitrogen.

The availability of the insoluble nitrogen in these brands ranged from 24 to 55 per cent. and the character of the materials used in these mixtures may be compared with the following figures which were obtained by the use of the same chemical method when applied to different materials known to be used in the manufacture of fertilizers:

Dried blood, high grade tankage, fish, 69-76 per cent; cotton-seed meal, medium tankage, bone meal, 55-67 per cent; leather preparations, 13-59 per cent; garbage tankage and peat, 23-41 per cent.

Summary of Results.

The following tabulation gives the names and addresses of the manufacturers of complete fertilizers whose brands have been examined this year, as well as a summary of the results obtained. In tabulating these results a deficiency of 0.20 per cent. in the total nitrogen and of 0.30 per cent. in phosphoric acid and potash have been disregarded.

Summary of the Results Obtained With the Mixed Fertilizers Examined During the Inspection of 1914.

Manufacturer.	Address.	Number of brands received.	Number of samples examined.	Number of samples satisfied guarantees.	Number of samples substantially equal to guarantees.*	Number of samples deficient in: Nitrogen.	Phosphoric acid.	Potash.	One element.	Two elements.	Three elements.
Acme Guano Co.	Baltimore, Md.	2	3	1	1			1	1		
Agricultural Supply Co.	New York City	7	7		2	1	4		5		
American Agricultural Chemical Co.	New York City	108	111	33	52	7	11	10	24	2	
Armour Fertilizer Works	Baltimore, Md., and Chrome, N. J.	18	18	1	4	4	8	5	9	4	
Atlantic Fertilizer Co.	Kearny, N. J.	2	2	1			1		1		
Baird & Son, James A.	Marlboro, N. J.	6	6	1	3		2		2		
Ballenger, John A.	Mullica Hill, N. J.	2	2	2							
Bascom, F. L.	Millstone, N. J.	1	1				1		1		
Baugh & Sons Co.	Philadelphia, Pa.	18	19	12	3	2	1	1	4		
Berg Co., The	Philadelphia, Pa.	7	7			1	3	2	6		1
Bon Arbor Chemical Co.	Paterson, N. J.	2	2	1							
Bouker Fertilizer Co.	New York City	20	22	6	10	1	1	1	6		
Brewer & Locke	Swedesboro, N. J.	3	4	2	2						
Brown, Wm. M.	Cedarville, N. J.	1	1		1						
Burlington Supply Co.	Burlington, N. J.	3	3	1	2						
Chamberlain, & Co., E. B.	Hightstown, N. J.	2	2		1		1		1		
Clark & Son, C. C.	Mt. Ephraim, N. J.	2	2	1				1	1		
Coe Mortimer Co.	New York City	13	13	3	7	2		1	3		
Collins & Son., J. S., Inc.	Moorestown, N. J.	5	5	1	4						
Consumers Chemical Corporation	New York City	3	3	3							
Consumers Fertilizer Co.	New York City	8	8	5	1	2			2		
Demaris, B. F.	Cedarville, N. J.	4	4		2		2		2		
Dilts, O. H.	Ringoes, N. J.	1	1	1							
Doughten, H. W.	Moorestown, N. J.	3	3	1		1		1	2		
Downward Co., J. D.	Coatesville, Pa.	2	2			1		1	2		
Dugan, John.	Moorestown, N. J.	2	2	1	1						
Elmer Grange, No. 29	Elmer, N. J.	1	1	1							
Fogg & Hires Co.	Salem, N. J.	1	1		1						
Glaser Co., The.	Plainfield, N. J.	3	3		3						

Gloucester County Grange	Mickleton, N. J.		1	1	1							
Griscom, J. C.	Woodbury, N. J.		1	1		1						
Hackett, Thomas Y.	Daretown, N. J.		1	1		1						
Hendrickson & Dilatush	Robbinsville, N. J.		7	7	1	1	1	3	1	5		
Hess, & Bro., S. M., Inc.	Philadelphia, Pa		5	5	3	2						
Hill, Thomas	Flemington, N. J.		1	1		1						
Hill Bros.	Flemington, N. J.		4	5	1	2		1	1	2		
Hoffman & Bro., P.	Raubsville, Pa.		2	2		1	1			1		
Hubbard Fertilizer Co., The.	Baltimore, Md.		3	3		1		1	1	2		
Hutchinson, Jr., H. H.	Robbinsville, N. J.		2	2		1		1		1		
International Seed Co.	Rochester, N. Y.		3	3	2				1	1		
Kauffman, M.	Bridgeton, N. J.		2	2	1	1						
Keystone Bone Fertilizer Co.	Philadelphia, Pa.		1	1	1							
Kumpf, Louis B.	Tuckerton, N. J.		2	2	2							
Lancaster, Wm.	Philadelphia, Pa.		3	3	2			1		1		
Lederer & Son, S.	New Brunswick, N. J.		1	1			1	1			1	
Lippincott & Bro, C. A.	Moorestown, N. J.		1	1	1							
Listers Agricultural Chemical Works	Newark, N. J.		26	26	3	10		13		13		
Ludlam Co., Frederick	New York City		1	1		1						
Mapes Formula and Peruvian Guano Co.	New York City		17	17	4	5		8		8		
Martin Co., D. B.	Philadelphia, Pa.		9	9	4	2	2		1	3		
Minch, John E.	Bridgeton, N. J.		4	4	2		1	1		2		
Minch Bros.	Bridgeton, N. J.		2	2	1	1						
Mitchell Fertilizer Co.	Tunley		2	2	1			1		1		
Monmouth County Farmers Exchange	Freehold, N. J.		6	6	3	2	1			1		
Nassau Fertilizer Co.	New York City		4	4	1	3						
Nelson Co., The Albert.	Allentown, N. J.		3	3	1	2						
Niedt & Co., O. F.	Trenton, N. J.	†	1	1								
Noll & Co., J. F.	Newark, N. J.		2	2				2		2		
Pancoast, S. L.	Mullica, N. J.		2	2	1	1						
Patapsco Guano Co.	New York City		6	6	3	3						
Philadelphia Guano Works	Philadelphia, Pa.		2	2		1	1			1		
Piedmont-Mt. Airy Guano Co.	Baltimore, Md.		2	2	1	1						
Pomsett & Davidson	Swedesboro, N. J.		1	1		1						
Ramsay, A. L.	Perth Amboy, N. J		1	1				1		1		
Rasin-Monumental Co.	Baltimore, Md.		7	8	2	2	1	2	2	3	1	
Reading Bone Fertilizer Co.	Reading, Pa.		7	7	1	1		2		2		
Reichard, Robert A.	Allentown, Pa.		2	2		1		1		1		
Roberts Co. Ellwood.	Philadelphia, Pa.		5	5	1	1	1	1	1	3		
Royster Guano Co., F. S.	Baltimore, Md.		15	15	7	7	1			1		
Ruckman Bros.	New Brunswick, N. J.		4	4		3			1	1		
Rue, Chas. E.	Windsor, N. J.		1	2		1			1	1		
Runyon, A. D.	Millington, N. J.		1	1	1							
Scott Fertilizer Co., The.	Elkton, Md.		5	5	2	1		2		2		
Shoemaker & Co., Ltd., M. L.	Philadelphia, Pa.		6	6	4		1		1	2		
Sickel, Henry L.	Woodbury, N. J.		5	5	3	2						
Smith Co., The Rufus W.	Elmer, N. J.		3	3		1	1		1*	2		

*Not over 0.20% low in nitrogen; 0.30% low in phosphoric acid or potash.
†-One sample not guaranteed.

Summary of the Results Obtained With the Mixed Fertilizers Examined During the Inspection of 1914—(Continued).

MANUFACTURER.	ADDRESS.	Number of brands received	Number of samples examined	Number of samples satisfied guarantees.	Number of samples substantially equal to guarantees.*	Number of samples deficient in: Nitrogen.	Phosphoric acid.	Potash	One element.	Two elements.	Three elements.
South Jersey Farmers Exchange	Woodstown, N. J.	11	12	5	5	2			2		
Standard Guano Co.	Baltimore, Md.	12	12	4	6			2	2		
Swift & Co.	Baltimore, Md.	4	5		3		1	1	2		
Swift & Co.	Kearny, N. J.	20	20	3	10	3	5	1	5	2	
Taylor Bros.	Camden, N. J.	1	1	1							
Taylor Provision Co.	Trenton, N. J.	4	4	1	1	1	1		2		
Thomas & Son Co., I. P.	Philadelphia, Pa.	14	18	1	8	8		3	7	2	
Trenton Bone Fertilizer Co.	Trenton, N. J.	20	20	3	12	3	2		5		
Tunnell & Co., Inc., F. W.	Philadelphia, Pa.	32	36	7	14	9	4	5	13	1	1
Tuscarora Fertilizer Co.	Baltimore, Md.	2	2		2						
Tygert Co., J. E.	Philadelphia, Pa.	8	8	5	2			1	1		
United States Fertilizer Co.	Baltimore, Md.	2	2	1	1						
Virginia-Carolina Chemical Co.	New York City	15	15	7	4	2	1	1	4		
Vreeland, A. J.	Matawan, N. J.	1	1	1							
Wenderoth & Sons, J.	Camden, N. J.	3	3	1	2						
West Jersey Marl and Transportation Co.	Woodbury, N. J.	10	11	6	4	1			1		
Whann Co., W. E.	Philadelphia, Pa.	5	6	2	2		1	1	2		
Wilde, Wm.	Vineland, N. J.	3	3	2				1	1		
Worthley, A.	Marlboro, N. J.	1	2	1	1						

*Not over 0.20% low in nitrogen, 0.30% low in phosphoric acid or potash.

II.

INSPECTION OF AGRICULTURAL LIME.

The act to regulate the sale of agricultural lime became effective on April 1, 1913. This law requires the various lime products to carry the following statements:—

1. The number of pounds of agricultural lime contained in each package. If the shipment is in bulk, the number of pounds in the shipment.
2. The name of the particular form of lime.
3. The name and principal address of the manufacturer or other person responsible for putting the material on the market in this State.
4. The minimum and maximum percentage of total lime. The minimum and maximum percentage of total magnesia. The minimum percentage of lime and magnesia combined as carbonates. The minimum percentage of lime sulphate in gypsum or land plaster.

The law also requires the various brands to be registered, and in accordance with this requirement 69 brands were registered by the following:—

J. E. Baker Co., York, Pa.; S. W. Barrick & Sons, Woodsboro, Md.; F. E. Conley Lime & Fertilizer Co., Utica, N. Y.; Judson Conover, Matawan, N. J.; G. & W. H. Corson, Plymouth Meeting, Pa.; Edison Portland Cement Co., New Village, N. J.; Fountain Rock Lime Co., Woodsboro, Md; Frazeur Lime Works, Bridgeton, N. J.; M. J. Grove Lime Co., Lime Kiln, Md.; Keasbey & Mattison Co., Ambler, Pa.; J. B. King & Co., New York City; Knickerbocker Lime Co., Philadelphia, Pa.; John Kreutz & Sons, Inc., Philadelphia, Pa.; E. J. Lavino & Co., Philadelphia, Pa.; LeGore Comb. Lime Co., LeGore, Md.; Weller C. Leigh, Lebanon, N. J.; Lukens & Yerkes, Philadelphia, Pa.; John Meehan & Son, Philadelphia, Pa.; Merion Lime & Stone Co., Norristown, Pa.; M. C. Mulligan & Son, Clinton, N. J.; E. J. Neighbour, German Valley, N. J.; Lowell M. Palmer, York, Pa.; Philadelphia Manure Co., Philadelphia, Pa.; Jerry Read & Son, Beatystown, N. J.; C. T. Russell, Jersey City, N. J.; Steacy & Wilton Co., Wrightsville, Pa.; Benjamin Stoner, Hellam, Pa.; Twining & Large, Yardley, Pa.; Vanderhoof Lime Co., Hamburg, N. J.; Charles Warner Co., Wilmington, Del.; White Limestone Co., Ogdensburg, N. J.

During the season, 32 samples were analyzed and the results are tabulated in Bulletin No. 274.

III.

INSPECTION OF COMMERCIAL FEEDING STUFFS.

The detailed report of the annual inspection of the commercial feeding stuffs was published in Bulletin No. 271, under the authority of the law which was approved March 28, 1912.

The new law contains some requirements that were not included in the law which was approved on March 25, 1900, consequently a large part of the work during the past year relating to these materials was devoted to adjusting the new conditions. Information regarding the requirements was furnished by correspondence and, also, by supplying copies of the law. In order that all interested in the subject would be fully informed, the full text of the law was published in Circular No. 10, in Bulletin No. 256, and in the annual report of 1913. Every request for information was promptly complied with,

and as there are copies of the law available, future requests will receive the regular prompt attention.

Inasmuch as the full text of the law has been so thoroughly distributed, it does not seem necessary to reprint it at this time. The main requirements, however, may be briefly stated as follows:

1. The registration of the materials showing the guarantees of protein, fat and fiber, and the specific names of each ingredient used in preparing the feed.

2. The information that has been registered must be attached to the material as sold.

3. On specified dates, July 1st and January 1st, every firm or person who has registered material for sale must render reports showing the total tonnage sold during the preceding six months.

4. The materials sold must equal the guarantees for protein and fat and must not exceed the guarantee for fiber, and, also, must contain the ingredients specified.

Registrations.

During the year 1913, 341 manufacturers registered 1,575 brands which represented the materials that would be offered for sale in the State. At the time of collecting the samples for analyses, the inspectors found 242 brands that had not been registered, 169 of which were prepared in New Jersey. In each instance the party responsible was informed regarding the necessity to comply with the law, and it was quite evident from the replies received that the large number of unregistered brands was largely due to a lack of information, while in a few cases it was due to neglect. As a result of this correspondence 212 brands were registered by the parties selling the same, and in seven other cases the particular shipments were attended to by the parties who bad made the purchase. It cannot be too strongly stated that this method of attending to the registrations is not in accordance with the law which prescribes the date when all registrations must be made. It is expected that in the future this condition will be more fully understood and that the registrations will be made at the proper time.

In accordance with the figures given above, it will be noted that there were 23 brands collected that were not registered. Although these brands should have been attended to hy the 16 manufacturers responsible for their appearance in the markets, explanations in regard to nine brands were made by seven manufacturers, which were accepted. One manufacturer having one brand made application for registration, but on account of the form not heing made out correctly, it was returned for correction. One of the other deficient samples was supposed to have been registered, but the material as sold stated it contained an ingredient not mentioned in the registration and, therefore, is not recorded as the brand.

There were seven manufacturers, however, who did not comply with the law as interpreted by the State Chemist in regard to the registration of some or all of their brands, and they have not shown

any inclination to do so. Their attention was repeatedly called to the condition, and as no results were obtained the matter has been referred to the legal authorities for adjustment. The names of these *parties are not given at the present time as we still expect that they* will comply with the law even at this late date, and in accordance with the policy adopted for this inspection, leniency will be shown as fas as possible. However, it can be safely assumed that if the registrations are not made, the cases will have to be settled in accordance with the law.

The above statements have been incorporated in this report for the purpose of showing the reasons for the deficiencies. It should be added here, however, that we have followed up the irregularities and have succeeded, in most of the cases, in securing a compliance with the requirements of the law regarding a registration of the brands and a statement of the guarantees on the packages as sold.

In the future it will be necessary to adhere more strictly to the requirements and, therefore, in order to avoid complications, each and every person who is manufacturing feeds or intends to make new brands should attend to the various details of the law as enumerated and at the proper time.

Statement of Ingredients.

The statement of the specific names of the ingredients used in preparing feeding stuffs is one of the important requirements of the law. The tabulations that appear in Bulletin No. 271 contain the ingredients claimed by the manufacturers in accordance with the statements on the packages. In each case the sample analyzed has been examined microscopically in order to determine the accuracy of the statements. Reports of our findings have been submitted to the manufacturers and attention called to any discrepancy found, but the ingredients as found are not published this year. Reports of the subsequent inspections will show the ingredients identified as well as those guaranteed.

Particular attention is called to the incorrect statements used by some manufacturers to designate certain ingredients. In the future these statements must give the "specific" names instead of the more general or abbreviated names as given. Some of the materials referred to have been simply called "bran," "middlings," "meal," while the correct name should have contained the name of the grain from which it was obtained, as wheat bran, wheat middlings, corn meal. The terms "Oil Cake" or "Oil Meal" are also used, but they are not specific since they are applied to ground cake from various sources and when used they should be preceded by the name of the material from which it was derived, such as linseed, cottonseed, etc.

The terms that are used should be expressed in accordance with the definitions that have been adopted by the Association of Feed Control Officials of the United States, the same being prepared with the

co-operation of the American Feed Manufacturers' Association. Most of the definitions have been presented in a previous bulletin, but on account of their importance they are herewith presented.

The definitions are as follows:

ALFALFA MEAL is the entire alfalfa hay ground, and does not contain an admixture of ground alfalfa straw or other foreign materials.

BLOOD MEAL is ground dried blood.

BREWERS' DRIED GRAINS are the properly dried residue from cereals obtained in the manufacture of beer

BUCKWHEAT SHORTS OR BUCKWHEAT MIDDLINGS are that portion of the buckwheat grain immediately inside of the hull after separation from the flour.

CHOP is a ground or chop feed composed of one or more different cereals or by-products thereof. If it bears a name descriptive of the kind of cereals, it must be made exclusively of the entire grains of those cereals.

CLIPPED OAT BY-PRODUCT (term oat clippings not recognized) is the resultant by-product obtained in the manufacture of clipped oats. It may contain light, chaffy material broken from the ends of the hulls, empty hulls, light immature oats and dust. It must not contain an excessive amount of oats hulls.

CORN BRAN is the outer coating of the corn kernel.

CORN FEED MEAL is the sifting obtained in the manufacture of cracked corn and table meal from the whole grain.

CORN GLUTEN FEED is that portion of commercial shelled corn that remains after the separaton of the larger part of the starch, and the germ by the processes employed in th manufacture of cornstarch and glucose. It may or may not contain corn solubles.

CORN GLUTEN MEAL is that part of commercial shelled corn that remains after the separation of the larger part of the starch, the germ and the bran by the processes employed in the manufacture of cornstarch and glucose. It may or may not contain corn solubles.

COTTONSEED MEAL is a product of the cottonseed only, composed principally of the kernel with such portion of the hull as is necessary in the manufacture of oil; provided that nothing shall be recognized as cottonseed meal that does not conform to the foregoing definition and that does not contain at least 36 per cent. of protein.

CHOICE COTTONSEED MEAL must be finely ground, not necessarily bolted, perfectly sound and sweet in odor, yellow, free from excess of lint, and must contain at least 41 per cent. of protein.

PRIME COTTONSEED MEAL must be finely ground, not necessarily bolted, of sweet odor, reasonably bright in color, yellow, not brown or reddish, free from excess of lint, and must contain at least 38.6 per cent. protein.

GOOD COTTONSEED MEAL must be finely ground not necessarily bolted, of sweet odor, reasonably bright in color and must contain at least 36 per cent. of protein.

COTTONSEED FEED is a mixture of cottonseed meal and cottonseed hulls containing less than 36 per cent. of protein.

CRACKLINGS are the residue after partially extracting the fats and oils from the animal tissue. If they bear a name descriptive of their kind, composition or origin, they must correspond thereto.

DIGESTER TANKAGE is the residue from animal tissue exclusive of hoof and horn specially prepared for feeding purposes by tanking under live steam, drying under high heat, and suitable grinding. If it contains any considerable amount of bone, it must be designated DIGESTER MEAT AND BONE TANKAGE.

DISTILLERS' DRIED GRAINS are the dried residue from cereals obtained in the manufacture of alcohol and distilled liquors. The product shall bear the designation indicating the cereal predominating.

FLAX PLANT BY-PRODUCT is that portion of the flax plant remaining after the separation of the seed, the baste fiber and a portion of the shives, and consists of flax shives, flax pods, broken and immature flax seeds and the corticle tissue of the stem.

GRITS are the hard, flinty portions of Indian corn without hulls and germ.

HOMINY MEAL, HOMINY FEED, OR HOMINY CHOP, is a mixture of the bran coating, the germ and a part of the starchy portion of the corn kernel obtained in the manufacture of hominy grits for human consumption.

MALT SPROUTS are the sprouts of the barley grain. If the sprouts are derived from any other malted cereal, the source must be designated.

MEAL is the clean, sound, ground product of the entire grain, cereal or seed which it purports to represent. Provided, that the following meals, qualified by their descriptive names, are to be known as, viz: CORN GERM MEAL is a product in the manufacture of starch, glucose and other corn products, and is the germ layer from which a part of the corn oil has been extracted. LINSEED MEAL is the ground residue after extraction of part of the oil from ground flaxseed.

MEAT SCRAP AND MEAT MEAL are the ground residues from animal tissue exclusive of hoof and bone. If they contain any considerable amount of bone, they must be designated MEAT and BONE SCRAP, or MEAT and BONE MEAL. If they bear a name descriptive of their kind, composition or origin, they must correspond thereto.

OAT GROATS are the kernels of the oat berry with the hulls removed.

OAT HULLS are the outer chaffy coverings of the oat grain.

OAT MIDDLINGS are the floury portion of the oat groat obtained in the milling of rolled oats.

OAT SHORTS are the covering of the oat grain lying immediately inside the hull, being a fuzzy material carrying with it considerable portions of the fine floury part of the groat obtained in the milling of rolled oats.

RED DOG is a low grade wheat flour containing the finer particles of bran.

RICE BRAN is the cuticle beneath the hull.

RICE HULLS are the outer chaffy coverings of the grain.

RICE POLISH is the finely powdered material obtained in polishing the kernel.

SCREENINGS are the smaller imperfect grains, weed seeds and other foreign material having feeding value, separated in cleaning the grain.

SHIPSTUFF OR WHEAT MIXED FEED is a mixture of the products other than the flour obtained from the milling of the wheat berry.

SHORTS OR STANDARD MIDDLINGS are the fine particles of the outer and inner bran separated from bran and white middlins.

WHEAT BRAN is the coarse outer coatings of the wheat berry.

WHEAT WHITE MIDDLINGS OR WHITE MIDDLINGS are that part of the offal of wheat intermediate between shorts or standard middlings and red dog.

Tonnage of Feeding Stuffs Sold.

The law requires reports to be filed on July 1st and January 1st of each year showing the tonnage of feeding stuffs sold during the preceding six months. In accordance with this requirement the following shows the number of tons of feeding stuffs sold during the year 1913: From reports due July 1, 1913, 93,664.17 tons; from reports due January 1, 1914, 102,560.00 tons; Total for year, 196,224.17 tons.

Inspection.

During the inspection, nine hundred and seven (907) samples were received, and of this number forty-eight (48) samples were forwarded for examination and were not official samples. These unofficial samples were examined and reports rendered in accordance with the requests, but the results obtained do not appear in the tabulations.

In order to make the inspection as thorough as possible, inspectors were directed to visit every county in the State, and the samples which were forwarded were drawn from the stock of 252 dealers or consumers, and a list of the addresses of the dealers and consumers would show that the samples represented and materials that were being sold in 146 cities or towns.

Guaranteed and Actual Composition.

Seven hundred and forty samples were examined during the past year, and of this number 131, or 17.7 per cent.,, did not satisfy the guarantees given, and this percentage would have been larger if certain allowances were not made when preparing the tabulation. These samples required 2,220 different guarantees which should have been satisfied by the material delivered, but there were 154 of this number which were not satisfied. These deficiencies consisted of the following. Protein 61, Fat 40 and Fiber 53; 112 samples being deficient in one nutrient while fifteen were deficient in two and four samples were deficient in the three nutrients.

The following tabulation is a summary of the whole inspection. It will be noted that the average composition and average selling price of Calf Meals, Feed Mixtures, Mash Foods and Poultry Grains are not given. These omissions are due to the variable character of the different materials represented.

In preparing this tabulation the protein as found is considered to

satisfy its guarantee if it is not more than one (1) per cent. below it. An allowance of one-half (½) per cent. is made for the fat and the same allowance is made for the fiber.

Summary of the Results of the Inspection.

FEEDING STUFF.	Number of Samples Examined.	Average Composition. Moisture.	Protein.	Fat.	Fiber.	Avg. Retail Selling Price Per Ton.	No. Samples Satisfied Guarantees.	No. of Samples Deficient in— Protein.	Fat.	Fiber.	One Nutrient.	Two Nutrients.	Three Nutrients.
		%	%	%		$							
Alfalfa Meal	13	8 86	14.66	1 69	27 95	31 67	12	..	.	1	1	..	..
Brewers' Dried Grains	16	8 18	27 17	6.53	13 19	26.88	10	3	1	2	6	..	..
Buckwheat Bran	3	13 48	28 90	7 60	4.66	26.50	1	..	..	1	1	.	..
Buckwheat Feed	2	13 83	23.72	5 69	7.82	26.00	1	1	.	1	..	1	..
Buckwheat Middlings	10	12 52	25.70	6 82	3 08	28.22	5	1	1	2	2	1	..
Buckwheat Offal	11	11.49	26.08	6.52	6.74	25.43	7	..	.	2	2	..	..
Calf Meals	4	....	...	....	....	.....	3	1	1	.	.	1	..
Corn Feed Meal	8	10 77	8 96	3 72	2 08	34.00	6	..	.	1	1	.	..
Corn and Cob Meal	10	13.34	7.59	3 85	6 08	25.87	9	..	1	..	1	..	..
Corn Germ Meal	1	6 70	17.75	7 15	5.39	30.66	1	.	.	.	..	..	..
Corn and Oats	30	11 07	10 07	4.37	3.61	34.07	21	1	4	2	7	..	..
Cottonseed Meal	14	7 36	40.37	7.86	8 55	34.95	12	2	1	..	1	1	..
Cottonseed Meal and Hulls	1	9 63	19 69	3 66	24.36	.....	....	1	.	1	..	1	..
Distillers' Dried Grains—Corn	3	6 37	29 40	10 35	9.52	34 00	1	1	1	..	2	..	.
Distillers' Dried Grains—Rye	1	6 10	15 56	7.23	14 04	26 00	...	1	..	.	1	..	.
Dried Beet Pulp	6	7.51	8 15	0.78	19 27	26.80	6	..	..	..	..	..	..
Feeding Flour	5	9.69	17 86	5 15	3.05	35.33	4	..	.	1	1	..	..
Feed Mixtures	164	....	...	....	....	.....	138	8	12	10	16	4	2
Gluten Meal	1	8.16	40.63	1.25	2 87	.....	1	..	..	..	..	..	..
Gluten Feed	15	8 53	23 49	3.19	6.68	32.06	15	..	..	..	..	..	..
Hominy Feed	1	7 91	8 75	6.06	10 61	28 00	1	..	..	..	..	..	.
Hominy Meal	10	8.64	11.27	7.33	4.07	29.43	10	..	.	..	..	..	..
Laxo Cake Meal	1	8 56	24 88	9.14	9.42	.....	1	..	.	..	..	..	..
Linseed Meal	9	8 47	32.90	6.77	8.36	35.50	8	1	.	..	1	..	..
Maizeline	2	8.01	8.79	7.27	7.95	30.50	2	..	..	..	..	..	..
Malt Sprouts	6	9.69	25.65	1.25	12.00	26 08	4	..	1	1	2	..	..
Mash Foods	53	....	....	....	....	.....	37	9	2	5	13	..	1
Meat Meal and Beef Scrap	27	6.90	48.75	14.15	....	23.47	14	12	3	..	11	2	..
Mustard Bran	2	7 33	21.42	9.95	15.74	44.00	....	..	..	..	..	..	..
Oat Hulls	2	7.08	3.25	1.09	30.10	.....	1	1	1	1	..	..	1
Poultry Grains	135	....	....	....	....	.....	111	9	8	7	20	2	..
Rye Bran	16	11 45	13 65	2.91	4.39	25.44	12	1	..	1	2	..	..
Rye Feed	2	13.41	12.50	2.53	2 65	27.00	2	..	..	.	..	..	..
Rye Middlings	18	12 01	11 70	2.60	2.53	26.66	12	1	..	4	3	1	..
Shredded Wheat	1	7.28	12.81	1.70	2.33	35.00	1	..	..	..	..	..	..
Wheat Bran	70	10.00	15.00	4.80	8.95	27.75	55	5	..	6	9	1	..
Wheat Feed	10	9.78	16 24	4.89	7.43	27.85	8	..	..	2	2	..	..
Wheat Middlings	52	10.45	15.82	4.70	4.59	30.93	42	2	3	1	6	..	..
Wheat and Rye Feed	5	11.49	14.05	3.90	4.66	29.33	4	..	..	1	1	..	..

IV.

INSPECTION OF INSECTICIDES.

The law of New Jersey regulating the sale of insecticides, Chapter 89, Session of 1912, requires the various materials that are sold for "preventing, destroying, repelling or mitigating any insects which may infest vegetation," to be registered at the office of the State Chemist. This registration consists of a statement of the name and address of the manufacturer, or the party responsible for its sale; the brand name of the material and the guarantee that will be attached to the material when offered for sale. The law also requires an annual inspection of these materials found in our markets, and the publication of the results as obtained.

In accordance with these requirements, the results of the work done during the year were published in Bulletin No. 273.

Registrations.

During the past year the following manufacturers registered one hundred and sixty-seven (167) brands of materials, and the certificates for the same were duly issued.

The manufacturers who made registrations are as follows:

Adler Color and Chemical Works, New York City; Walter A. Allen, Quakertown, N. J.; Ansbacher Insecticide Co., New York City; Aphine Manufacturing Co., Madison, N. J.; E. J. Barry, New York City; James A. Blanchard Co., New York City; Bowker Insecticide Co., Boston, Mass.; Burlington Supply Co., Burlington, N. J.; Corona Chemical Co., Milwaukee, Wis.; Danforth Chemical Co., Leominster, Mass.; F. W. DeVoe & C. T. Raynolds Co., New York City; The Dow Chemical Co., Midland, Mich.; Entomoid Chemical Co., Keyport, N. J.; Samuel H. French & Co., Philadelphia; The Grasselli Chemical Co., Cleveland, O.; Hammond Pain & Slug Shot Works, Beacon, N. Y.; Hemingway & Co., Inc., Bound Brook, N. J.; Morris Herrmann & Co., New York City; Interstate Chemical Co., Jersey City, N. J.; The Kil-tone Co., Newark, N. J.; Fred L. Lavanburg, New York City; Arthur Laver, Bernardsville, N. J.; Leggett and Brother, New York City; Lehn & Fink, New York City; John Lucas & Co., Inc., Gibbsboro, N. J.; Mechling Bros., Manufacturing Co., Camden, N. J.; A. Mendleson's Sons, Albany, N. Y.; Merrimac Chemical Co., Boston, Mass.; Niagara Sprayer Co., Middleport, N. Y.; I. Pfeiffer, New York City; The Plantlife Co., New York City; Powers-Weightman-Rosengarten Co., Philadelphia; B. G. Pratt Co., New York City; The Rex Co., Rochester, N. Y.; Schering & Glatz, New York City; The Sherwin-Williams Co., Cleveland, O.; Smith, Kline & French Co., Philadelphia; Spray Chemical Compounding Co., Buffalo, N. Y.; Sterling Chemical Co., Cambridge, Mass.; The H. A. Stoothoff Co., Mt. Vernon, N. Y.; Thomsen Chemical Co., Baltimore, Md.; Vreeland Chemical Co., Little Falls, N. J.; Wilson, Edmondson Co., Milburn, N. J.

Chemical Examinations.

The brands collected were examined by use of the official methods, with the exception of the method for water soluble arsenic, the figures reported for this constituent being obtained after a one-day extraction.

Sixty-six samples of the various materials were examined and consisted of the following.—22 samples of Paris green, 14 samples of lead arsenate, 6 samples of lime sulphyr solution, 4 samples of bordeaux mixture, 20 samples of miscellaneous brands.

Report of the Horticulturist.

MAURICE A. BLAKE, Horticulturist,
CHARLES H. CONNORS, Assistant in Horticultural Investigations.

The work of the horticultural division is being continued along much the same lines as reported for 1913. The peach investigations continue to be the most important series of investigations of the division out of doors, while the investigations with roses and carnations in the greenhouses are regarded as of equal importance. These two series comprise a considerable number of individual projects quite closely related in their own particular series.

A pruning experiment with apples is a project planned along similar lines to the peach pruning experiments, and promises to give results of equal interest and value.

A pear orchard of one and one-half acres was planted at the College Farm in the spring of 1913 as a demonstration and laboratory orchard for student exercises. This orchard has been planned in such a way, however, that many facts of scientific and practical value should be established.

Observations and studies of various varieties of peaches, pears, apples, plums, cherries, quinces, bush fruits, grapes, strawberries, carnations and roses are conducted from year to year in order to meet the demand for information upon variety characteristics.

The appointment of an extension fruit specialist in the station has enabled the division to greatly extend its services to the fruit growers of the state. Mr. A. J. Farley was appointed extension specialist during the past season, and owing to his thorough knowledge of fruit growing conditions throughout the state, received more requests for visits of inspection, demonstration and advice than could be met. During the peach harvesting period the requests for information and demonstration upon the packing of peaches in carriers was so urgent that the extension specialist was obliged to give his entire time to the work. Beginning September first, Mr. Farley was transferred to teaching work in the College and Mr. W. W. Oley was appointed as extension specialist in fruit production.

Weather observations and records at the College Farm have been continued during the year with Mr. Earl C. Stillwell as observer. Beginning September first, Mr. A. J. Farley took charge of this branch of the work.

The correspondence of the department now amounts to more than 4,000 letters annually. Many requests for information and assistance

are of an urgent character and replies to such inquires should be sent out within from 24 to 48 hours. When the horticulturist is obliged to be at the experiment orchard at Vineland for several days replies to correspondence are necessarily delayed.

LIST OF PROJECTS UNDERTAKEN BY THE HORTICULTURAL DIVISION.

The following is a general list of projects now under investigation by this division:

Fertilizer experiments with apples, (Standard): fertilizer experiment with apples, (Dwarf), pruning experiments with apples, (Standard): pruning experiments with apples, (Dwarf). pruning experiments with peaches; pruning experiments with pears; cover crop experiments with dwarf apples and peaches; a test of dynamiting for tree planting; variety test of apples, pears, peaches, plums, grapes and small fruits; fertilizer experiments with peaches; investigations with peach yellows and little peach; breeding experiments with peaches; spraying experiments with peaches.

GREENHOUSE PROJECTS—Soil studies with carnations; lime experiments with carnations; bench construction for carnations; moisture studies with carnations; planting experiment with carnations; determination of the amounts of plant food used by carnations; breeding experiments with carnations; variety test with carnations; soil texture studies with roses, moisture experiments with roses; lime experiments with roses; fertilizer experiments with roses; determination of the amounts of plant food used by roses; variety test with roses.

WHITE GRUBS OR LARVAE OF THE MAY BEETLE IN GREENHOUSE SOILS.

The larvæ of the May beetle or June bug are quite common in compost piles, and are often found in large numbers in sod piles composted for use in the greenhouse. Great damage not infrequently occurs to chrysanthemums when benched in soil infested with these insects, and sometimes to roses.

It is a rather puzzling fact that when the small larvae of this insect are transferred with the soil from the compost pile to the rose benches that most of them die after a short time. Yet when chrysanthemums are benched in such a soil damage to the plants is not uncommon. In any case, it is rather unsafe to trust to fate to destroy these grubs after they have been placed in the greenhouse.

When soil mixtures were prepared in May and June for experiments with roses at the experiment station greenhouses, the manure was found to be well infested with white grubs in all stages of development. Upon considering the amount of damage these might do to the plants, it was necessary to devise some means of ridding the soil of this pest.

Carbon bi-sulphide suggested itself, but this substance is so highly inflammable as to be dangerous for indiscriminate use, so a material that could be handled by almost anyone was sought, and commercial Formaldehyde containing 40 per cent. of formic aldehyde was chosen. Some plots in a greenhouse that had been filled presented the first problem. This soil was found to be very badly infested with grubs, about one-fourth of which were small, one-half medium sized and one-fourth large.

The soil was treated with a solution of Formaldehyde, one part to seventy-five parts of water. This was applied with a sprinkling can as the soil was being turned with a fork. After a few hours, an examination

of these soils showed that about 50 per cent. of the grubs had been killed. These latter included most of the medium sized grubs, the small ones and the large ones being still alive. A second application was made, the strength being increased to one part of Formaldehyde to fifty parts of water. A still larger proportion of the grubs were killed, the small and the large ones remaining alive.

Dr. T. J. Headlee, the Station Entomologist, was asked for an explanation of this resistance and explained it as follows:

The killing of the medium sized grubs was due to either one or both of these two factors: The grubs may have recently moulted, rendering the skin or tegument very tender; or else they were in a more active state of metabolism. It is probable that the larger grubs had such a tough tegument so well protected with hairs and spines that the gas could not touch them. This would seem true, for some of the large ones were placed in straight Formaldehyde and swam around in it for nearly a half-hour with apparently no injury to themselves. This testifies to the toughness of the tegument, for the gas was sufficiently strong to severely irritate the mucus membrane of the throat and nose of the workmen. The reason the small grubs were not killed is probably that they were in a low state of metabolism.

The manure pile was treated with 1-50 solution, turning it with a fork and soaking it well with the solution applied by means of a sprinkling can. This was allowed to stand for a few hours and the soil was then prepared and put into the benches. In this location it was forked over and stirred several times, after which an examination showed that nearly all the grubs were dead and the danger of loss from this pest reduced to a minimum.

In order then to avoid loss of plants in the greenhouse from attacks of the white grub, it would be well to examine the manure and compost piles for this insect, and, if found in the materials, to treat these as follows: Apply a solution of one part of Formaldehyde to fifty parts of water to the manure or compost by means of a sprinkling pot as the material is forked over, and in sufficient quantity to fairly well saturate the material. Allow to rest for a period of a half day, and then put into the bench. After the soil mixture is placed in the bench, it should be turned several times and allowed to aerate for several days after which the plants can be benched with safety and with little danger of loss from grubs.

FLORICULTURAL INVESTIGATIONS.

The investigations with carnations and roses have been extended and continued during the past season. Many notes and facts have been obtained relating to the factor of humidity in rose culture, and these will be published in bulletin form as soon as the funds are available.

The lime experiments with roses were extended in June, 1914, to include a comparison of slaked magnesium limestone with slaked calcium limestone. Injury from the use of large quantities of slaked magnesium has already occurred to the plants.

An extended study of the effect of different soil textures upon the growth of carnations and roses has brought out the fact that there is a marked variation in the behavior of different varieties, especially of roses. My Maryland has developed poorly upon a soil type that apparently favors Pink Killarney. Progress is being made in the breeding work with carnations.

Mr. D. M. Jobbins, the station florist, has made a number of trips to different points in the state to assist florists with their problems, and the requests for such assistance are steadily increasing. Mr. Jobbins is also in charge of the practical management of the station greenhouses in which the investigations are conducted and the success of the work largely depends upon his careful observation and management.

SPRAYING EXPERIMENTS TO CONTROL ROSE MILDEW AND BLACK SPOT.

The control of mildew and black spot in the greenhouse is a large problem. The present method of fumigating with sulphur or of sprinkling the plants with flowers of sulphur gives fairly good control of mildew; but if some fungicide could be found that would be safe to use upon rose foliage under any condition, the control of these diseases would be a much simpler matter.

There is much danger in the use of fungicides containing copper, as the copper in these compounds readily oxidizes in the moist atmosphere of the rose house, especially if sulphur is used. The soluble sulphur compounds, lime-sulphur and such materials as sulfocide always stain the foliage even if no burning results, which fact will be sufficient to discourage their use.

In "The American Florist" for June 14, 1913, there appeared a brief of a paper by Dr. A. R. Waddell in the annual of the National Rose Society of England for 1912-1913. This paper described the work of the author in the control of black spot and mildew on roses in the garden. Perfect control of these diseases was secured by the thorough use of a spray consisting of one part of formaldehyde to 250 parts of water. Formaldehyde is a commercial solution containing about 40 per cent. of formic aldehyde.

This article suggested the possibility of the value of this material in the greenhouse. Field conditions, however, are in no way comparable with greenhouse conditions. Where a very high humidity must be maintained, the best condition for the growth of the fungi occurs. It is also true that the plants in a greenhouse are much more succulent than in the field, and hence are much more liable to injury. Then too, there is a great variation in the foliage of different varieties, rendering some more susceptible to injury than others.

In an experiment to test the value of this material in the greenhouse, American Beauty rose plants were potted up and allowed to reach a good condition of growth. They were then sprayed with Formaldehyde in the following dilutions: 1 to 300, 1 to 250, 1 to 200, 1 to 150, 1 to 100.

All of these dilutions were used with perfect safety on these roses, no burning resulting. The plants when potted were rather badly infected with black spot, but after they were sprayed, the spot ceased to spread.

Since there was no burning on American Beauty, it was decided to try it on Killarney for mildew. The foliage of Killarney is notoriously more tender than that of the American Beauty, so it was not advisable to use as strong a dilution. A solution of one part of Formaldehyde to 250 parts of water was applied to the plants. The results were rather disastrous, as nearly all the leaves were lost from the plants, necessitating the topping of the plants and the consequent loss of a whole crop.

This illustrates well the danger in the use of untried spray materials. While this application was made with what was thought to be a wide enough margin for safety, it can be seen that no margin is wide enough unless it has been previously tried out. Further experiments with this material will be carried on, in the meantime the florist is warned to go slow in the use of this and other unknown or untried substances, except in an experimental way.

SPRAYING EXPERIMENTS TO CONTROL THRIPS UPON ROSES IN THE GREENHOUSE.

Florists in common believe that thrips are the cause of malformed buds upon American Beauty roses, and many materials have been tried as remedies. The mouth parts of the thrips are exceedingly small, and the common arsenicals such as Paris Green and arsenate of lead are not effective as commonly applied for the control of leaf chewing insects.

Several florists have tried a combination of sugar, water and Paris Green with apparent success against this insect. It is known to chemists that certain of the metals will form salts of certain acid-like constituents of the sugars. Among these are the suchrates and the glucosates. It is probable that this change occurs in this case, with the possible formation of arsenic suchrate or arsenic glucosate.

A mixture of sugar, water and Paris Green was applied to the American Beauty roses in the Experiment Station greenhouses with apparently successful results and no burning of any consequence noted. This brought out the suggestion that molasses might possibly be a cheaper material to use than sugar, so a mixture of molasses, water, and Paris Green was applied to the foliage, and severe burning ensued.

The cause of this burning was probably the oxidation of the arsenic in the compound to soluble arsenic. In the Paris Green there is more or less of the soluble oxide of arsenic which always burns foliage. This oxidation would come about through the action of the sulphur dioxide which is formed when sulphur is burned. The oxidizing action of sulphur dioxide is strong in the presence of moisture, which is found in a rose house in the form of humidity.

This burning led to the test of several mixtures upon roses in pots. An outline of the experiment is shown in Table No. 1. American Beauty rose plants in pots were used for this experiment. Two plants were used for each treatment, a sufficient number being left unsprayed for a check.

Table No. 1.

Treatment.	Spreading Material.	Quantity.	Paris Green.	Water.
No. 1	White Sugar	3 lbs.	1 tablespoon	12 qts.
2	" "	3 "	2 "	12 "
3	Brown Sugar	3 "	1 "	12 "
4	" "	3 "	2 "	12 "
5	Molasses	1 qt	1 "	12 "
6	"	1 pt.	1 "	12 "
7	"	1 qt	2 "	12 "
8	None		1 "	12 "
9	None		2 "	12 "

The first application was made on August 29. Burning showed first on September 2, the maximum of burning being reached on September 4. The treatment was repeated on September 7 and the injury began to show the next day. The results are shown in Table No. 2.

Table No. 2.

RESULTS OF SPRAY APPLICATIONS.

Treatment.	Spraying of Aug. 29 Burning.		Spraying of Sept. 7 Burning.	
	Sept. 2	Sept. 4	Sept. 8.	Sept. 9.
No. 1	None.	Very slight.	None.	None.
2	Very slight.	Slight.	None.	None.
3	Very slight	Slight	None	None
4	Very slight	Slight	Slight	Slight
5	None	Very slight	Slight	Severe
6	None	Very slight	Very slight	Slight
7	Severe	Very severe	Slight	Very severe
8	None	None	None	Slight
9	None	Slight	Very severe	Very severe

It will be noted that the mixture containing white sugar gave no serious burning at either application, while brown sugar used with the larger quantity of Paris Green gave a slight burning at both applications. Molasses is unsafe to use. Aside from the fact that all mixtures in which it was used gave severe burning, it was very "messy," and attracted the flies, so that the foliage was unfit for the market.

SOME ABNORMAL FORMS OF PLANT GROWTH.

(Charles H. Connors.)

Among plants and animals are constantly appearing forms which are departures from the normal. Some of these forms, however, appear so commonly that they have come to be considered the usual form. Among these may be mentioned the St. Bernard dog which has seven toes on the front paw; the wide bloom of the common coxcomb, Celosia cristata, which is due to faciation; and the flattened stem of the sweet potato, which is also due to faciation. Doubling in flowers such as the rose and the carnation are really abnormal forms, as botanically both of these plants have single blooms. Doubling in the carnation was discussed in the report of this Station for 1913.*

That branch of Botany that relates to the study of these variations is known as Teratology, and the variations are known as monstrosities. While there are monstrosities that are so common as not to be considered as such, there are others that are not so common in occurrence.

*N. J. State Agr. Expt. Sta. Rpt. 1913, page 135.

FIGURE 1.—Retrogressive metamorphosis in flowers of dewberry.

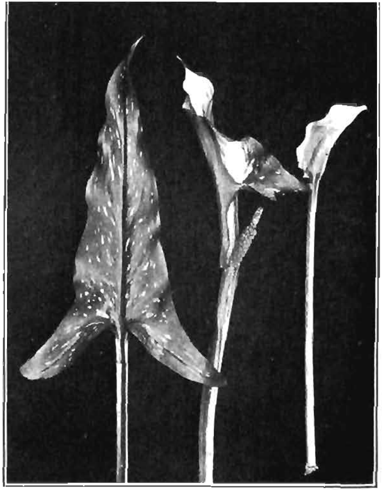


FIGURE 2.—Bloom of Spotted Calla in which the corolla becoming leaf-like.

FIGURE 3. Bloom of a tomato which is much faciated.

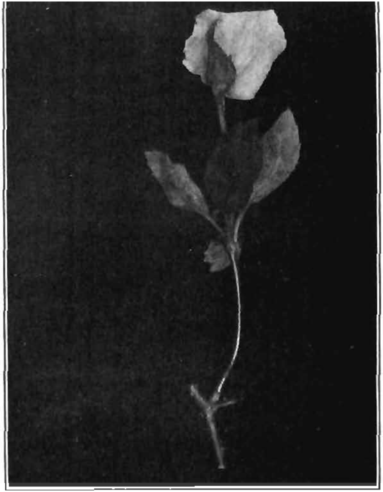


FIGURE 4. Unopened bud of Killarney Rose with a petal in the position of a sepal.

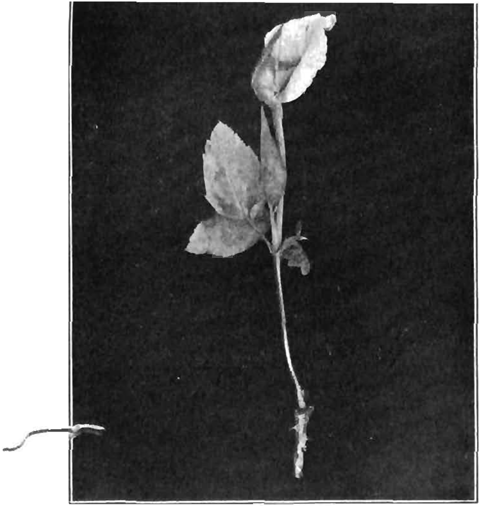


FIGURE 5. A side view of the same flower as shown in Figure 5

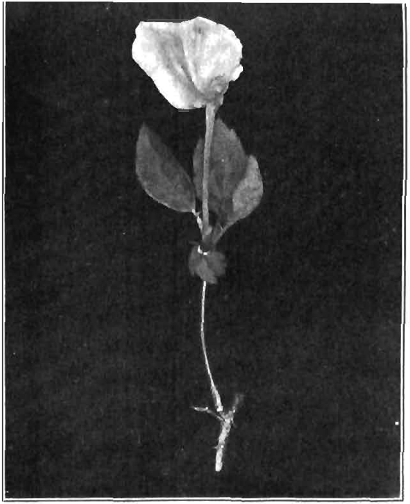


FIGURE 6.—Another view of the bud showing the sepal-petal.

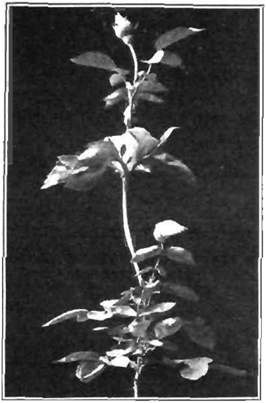


FIGURE 7.—A *Killarney* rose plant with a whorl of petals below a bud.

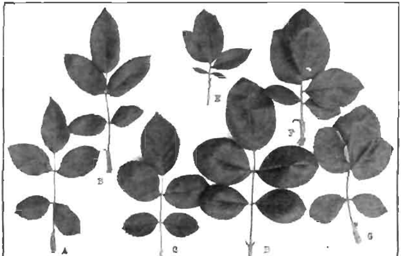


FIGURE 8.—Various forms of leaves of American Beauty Rose.

Phyllody of the Corolla.

Several of the nurserymen are listing what they call the green dahlia. This is apparently a green flower, and it propagates true by cuttings and tubers, but it can hardly be called a flower in the true sense of the word. The "flower" really consists of sepals, for the petals have all been changed into organs like sepals or bracts, and are stiff and hard like those chlorophyll-bearing parts. Blooms are often seen in which a few of the organs still retain the nature of petals, and are white or white and green.

While walking through a field of Lucretia dewberries the monstrosity shown in Fig. 1 was found. It will be seen that nearly all the petals have assumed a leaf-like form, in that they have become green. In addition to that, the stamens and pistils have taken the form of leaves with intended margins. This is a very good example of retrogressive metamorphosis.

Fig. 2 illustrates a bloom of the spotted calla in which the corolla has partly changed to a green leaf-like structure.

Effect of Double Flowers.

It has been observed at this station that the first blossom on a tomato vine is frequently a double flower, which develops into an irregularly shaped fruit. This fact is especially true of certain varieties, such as Atlantic Prize, Earliana, and Ponderosa, for example, which bears a large number of rough, uneven fruits.

Fig. 3 shows a blossom of a tomato after the petals have fallen. This is undoubtedly an example of faciation. From the broad stem, it may be seen that several cords that were intended to form separate flowers have been diverted from the original course and united to form a single one. More than that, however, the sepals are developing into leaves. It is extremely doubtful whether a fruit would develop from this. The metamorphosis has gone so far that it is probable that the fruit has also undergone change, and has become transformed into a stem-like or leaf-like form.

Petalody of the Sepal.

A Killarney rose bud appeared upon a potted plant that bore a resemblance to a sweet pea bloom. In this case, the flower retained the normal number of sepals, five, so it is evident that while the petal had probably developed from a sepal, another sepal had divided to make the normal number of sepals.

These freaks are all caused by some modification of the conditions of growth. Some of them, as was shown in the case of the carnation in the Report for 1913, are caused by a favorable change and some by an unfavorable change of environment.

In our studies with roses, certain conditions of growth have been found which were obviously caused either by the excess of plant food, a lack of nourishment, or by some injury to the plant itself. Such a case is shown in Fig. 7. This is a Killarney rose which began to set bud, probably because of a check to its growth. The result was the formation of a whorl

of petals. After these had formed. conditions occurred favoring a rapid growth, resulting in a continuance of the flower stem, and the formation of a new flower bud above the point of the previous attempt at bud setting with a whorl of petals left at the latter point.

Rate of Growth of Plants Indicated in the Form of the Leaves.

The first indication of the rate of growth of the plant is seen in the leaves. In Fig. 8 are shown a number of leaves taken from plants of American Beauty rose varying in rate of growth. These show that the growth of the plant or the growth of the stem on which the leaf is borne affects the shape of the leaf. Leaves (A) and (B) in Fig. 8 are taken from stems that are not growing very fast. (A) is seen to be very much pointed and the growth is very hard. (B) is growing a little faster and is a little more rounded and not quite so hard as (A). (C) is making a moderate growth, the leaves being still more rounded and of a softer nature. (D) is making a moderately fast growth and the leaflets are almost round. (E), (F), and (G), are making a very fast growth, so fast that the leaflets are not formed separately, but are, in many cases, joined together. The color of the leaves also varies considerably, (A) and (B) are a medium green; and (E), (F), and (G) are a dark purplish green. *The shape of the leaf and the color of the foliage may be taken as an index of the growing conditions of the plant.*

A part of a stem of an American Beauty rose is illustrated in Fig. 9. The stem had been pinched or topped at point (A) by the removal of the bud to lengthen the stem. The leaves are shown removed from the stem, but in the same relative position in which they grew. It will be noted that the leaves below the node have well-rounded leaflets, especially the leaf that grew just below the node. Just above the node, where the renewal of growth began gradually, following the pinching, the leaflets become very much pointed. As the rapidity of growth is increased, the leaflets become more rounded, and, at the third leaf above the node, the growth had attained the same rate as when the stem was topped, and the leaflets are again very much rounded.

Such variations as are shown in Figs. 10 and 11 may and do appear where the growth is rapid and succulent. These variations are confined mostly to the slender stems. The formation of a terminal bud checks the prolongation of the stem and upon rapidly growing vigorous shoots of the American Beauty rose growth is pushed out at the node immediately below the bud. In some cases upon weaker and more slender shoots bud formation is attempted but not completed because of the rapid growth of the stem. In Fig. 10 the petals may be seen scattered along the stem.

Malformed Flower Buds.

Malformed flower buds may be due to a number of causes. Unfavorable temperatures and injuries of various sorts are sometimes responsible. Florists frequently complain of squatty or malformed buds upon American Beauty roses.

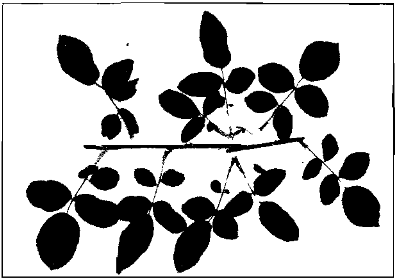


Figure 9.—A portion of a stem of American Beauty Rose.

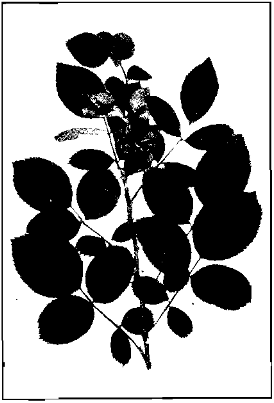


Figure 10.—Tip of a growing shoot of an American Beauty Rose with petals scattered along the stem.

FIGURE 11.—Growing tip of an American Beauty Rose stem with two petals at second node.

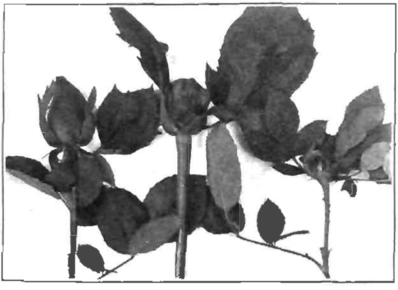


FIGURE 12.—Normal and distorted buds of American Beauty Rose.

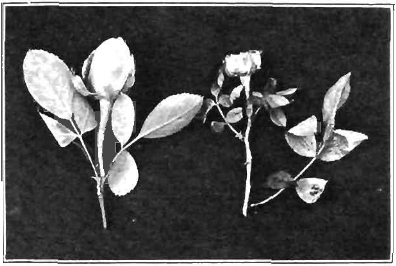


FIGURE 13.—A normal and a flattened bud of American Beauty Rose

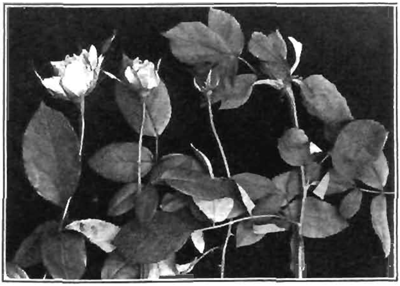


FIGURE 14.—Malformed buds of Sunburst, My Maryland, Milady and American Beauty Roses.

In general the causes of these are likely to be checked root development or a too rapid growth, the form of the bud varying somewhat in each case. Thrips are usually assigned as the cause of the malformed buds resulting from excessive growth, but it is now believed that while injury by thrips may cause this distortion, by far the larger part of them are caused by too rapid growth or by unfavorable conditions for root development.

Pointed and squatty buds from American Beauty roses are illustrated in Figs. 11 and 12. The bud at the left in Fig. 11 is a normal pointed bud of the American Beauty rose. The bud in the center is a malformed bud from a plant that was in a very rapidly growing condition. The stem is thick, there is a transformation of the sepals into leaves and a faciation of leaflets in one of the leaves so formed. While there is a partial transformation of the sepals in the normal bud, it will be noted that only one of the sepals has retrogressed so far as to be called a leaf, and this, too, has the leaflets faciated, showing that formation of a good bud requires a fairly rapid growth, but not so rapid as to cause a malformation.

According to the accepted theory of the origin of floral organs, the various parts of the flower have originated with leaves. Referring to the caption "Phyllody of the Corolla,"* a blossom of the dewberry (one of the Rosaceas) is shown in Fig. 1 in which the floral parts have all been changed into leaf-like forms. The petals are smaller than they would be if they were the normal white. In the majority of the squatty buds of the American Beauty rose, the outer petals have a trace of green and often a large part of the petal is green. Since the presence of chlorophyll in the petals causes a shrinkage in the size of the petal, and since the outer petals of these squatty buds are nearly always partly green, it can be deduced that this flattening of the bud is caused by the partial retrogressive metamorphosis of the petals, which is brought about in this case by very fast growth.

The bud shown at the right in Fig. 11 was taken from a plant of American Beauty rose that was making a very slow and weak growth. That it was making very slow growth is evidenced by the fact that the last internode is very short, and in addition a well developed thorn is found on this node. Thorns appear on wood that is hard and growing slowly and rarely on the upper or last node. It will be noted also that the leaf is rather pointed, and that the sepals are transformed into leaves, but that the leaflets in the latter case are rather pointed. One of the outer petals is apparently becoming serrated in a leaf-like fashion. The phenomenon of retrogressive metamorphosis can be brought about by very slow growth as well as by very fast growth. This bud is malformed because the stem is making a very slow growth, due to restricted root action. This may be, and probably is, caused by improper aeration of the soil, due to excessive moisture.

A squatty bud caused by another form of root injury is shown at the right in Fig. 12. This bud was cut from an American Beauty rose that was growing on very acid soil. The acidity had the effect of destroying nearly

*Page 41.

he entire root system of the plant except at the very surface. These nalformed buds are also found on other varieties of roses, as illustrated in ʼig. 12. The second bud from the right is a malformed bud of Milady. At he Experiment Station greenhouses very few buds of Milady have been of he normal kind; the majority having been of the squatty kind here picured. This distortion is probably due to soil conditions. If the soil is too vet, or too open and not of the proper texture to suit the variety, this fault ften appears.

Malformation of Buds Due to Cyanide Fumigation.

The fumigation of rose houses with potassium cyanide is likely to cause njury to the plants unless very carefully done. Even slight injury to ılants is indicated by the leaves in most instances. The sepals of formng buds, however, appear even more susceptible than young leaves and ollowing a fumigation in the Experiment Station greenhouses this sort f injury was found to have occurred to the sepals of the partly developed uds. When these buds were fully developed, a number were found to be quatty. Two of these buds of the varieties Sunhurst and My Maryland re shown in Fig. 13, the first and second specimens from the left. Similar njury was also noted in American Beauty.

Malformed buds upon roses may be due to several causes and injury by hrips is not believed to be as common as reported.

EFFECT OF POTASH UPON MY MARYLAND ROSES.

In June, 1909, an experiment with My Maryland roses was undertaken to tudy the effect of different amounts of potash upon roses. The soil conisted of Penn loam with 20 per cent. of sand and 20 per cent. of composted ow manure. The latter was added as florists commonly use from 20 to 5 per cent. of composted manure in their rose soils. The experiment was onducted upon a raised bench with wooden sides and a tile bottom, and e soil in the bench was 4 inches deep. The plots contained 15 square et of bench surface and were set with 15 plants of My Maryland rose.

The different potash treatments outlined were as follows: No potash, Plot No. 1); 1 gram of high grade sulfate of potash weekly, (Plot No. 2); grams weekly, (Plot No. 3); and 5 grams weekly, (Plot No. 4).

Each plot in this experiment received 272 grams ground limestone, 204 rams acid phosphate, 54 grams bone meal and 50 grams of dried blood at e beginning of the experiment, which were applied and mixed with the il before the plants were benched. Concentrated tankage at the rate of 7 grams per month was applied to each plot after the plants were estabshed.

The shoots of the young plants were pinched back from time to time hile they were small to prevent flowering and to secure longer and etter stems.

The first crop was cut during October and November, 1909, and the yields ppear in the following table:

FIGURE 15.—Grades of My Maryland Roses as recorded in the potash experiment.

FIGURE 16.—Flower stems of My Maryland Roses with one or two pinchings. Bloom at extreme left had a stem 40 inches in length.

Table No. 3.

RECORD OF YIELD OF FIRST CROP OF ROSES UPON POTASH PLOTS.

Grades.	No Potash.	One Gram.	Two Grams.	Five Grams.
Special	26	12	9	12
Fancy	39	49	40	47
Extra	46	43	56	58
Culls	....	..	1	1
Total	111	104	106	118

The different grades of roses indicated in table No. 3 are made up as follows:

Special: Good flowers with stems 24 or more inches in length
Fancy: Good flowers with stems 18 to 24 inches in length.
Extra: Good flowers with stems 12 to 18 inches in length.
Culls. Flowers with very short stems.

This is one of the older methods of grading roses of this type, but as the pinching back method of culture was practiced it was necessary to indicate the extra quality of the flowers cut and this system of grading appeared to meet the conditions best. Fig. 14 illustrates the four grades made of My Maryland roses.

In order to get good length of stem, all shoots were pinched back twice when necessary. It is probable, however, that a larger total of flowers would have been secured if no pinching back had been practiced, although the average grade would have been lower. Another experiment to test this point is being conducted, and will be reported upon later. The uniformly long stems secured in the flowers cut in these experiments is due to favorable conditions of culture, and to the pinching back of the shoots. The results, as indicated in table No. 3, show that the plot receiving 5 grams of high grade sulfate of potash weekly, produced 7 more flowers in actual total than the check plot, but this difference is in extra or third grade flowers. No differences were noted between the various plots in color or firmness of the flowers.

The plot receiving one gram of high grade sulfate of potash weekly gave the lowest total yield for the first crop, and for some reason has continued to hold this position, but it is very doubtful if the fertilizer application has anything to do with this variation.

The behavior of the plots for the next three crops is similar in all respects to that indicated by the first crop.

Four crops of My Maryland roses were cut from the potash plots from June, 1909, to August, 1910. The plots which have received two and five grams of sulfate of potash weekly have produced a somewhat larger total of flowers, although the difference is confined to third grade flowers. A total of the special and fancy grades of flowers produced upon all plots shows almost perfect uniformity as follows: Check, no potash, 240 flowers; one gram of potash weekly, 242 flowers; 2 grams of potash weekly, 243 flowers; and 5 grams of potash weekly, 240 flowers.

*It might be expected, perhaps, that with a soil containing 20 per cen*t of composted cow manure there would be no deficiency of potash for th first season. This seems to be borne out by the results as far as th variety, My Maryland, is concerned. The liberal application of 5 grams o high grade sulfate of potash weekly apparently had very little effec either beneficial or otherwise.

No additional soil or manure was added at the end of the first season but the following fertilizers were applied to each plot; 272 grams groun limestone and 102 grams of acid phosphate. Through a misunderstanding 2 grams of potash were applied to each plot including the no potash plot The weekly applications of potash and the monthly applications of concen trated tankage were applied at the same rate as during the first season.

The first crop of the second season was cut during September and Octo ber, 1910, and the check plot was fully equal to any other. The secon crop was cut from December to February.

The plots show a very uniform yield for this crop, Plots 1 and 2 bein equal in total and quality. Plot 3 has produced a few more high grad flowers than any other plot, while Plot 4 is somewhat lower than th others in total. The differences between the plots are slight, however.

The total number of flowers cut from each plot from the beginning of th experiment, up to and including the second crop of the second season, ar as follows: *Plot No. 1, check, 539; Plot No. 2, 1 gram of potash weekly* 607; Plot No. 3, 2 grams of potash weekly, 550; and Plot No. 4, 5 grams o potash weekly, 519 flowers.

Plot No. 3, which has received two grams of high grade sulfate of potas weekly, has produced the largest number of flowers to date. Plot No. 1 which has received no potash except the two grams applied by mistake, i second in total production. Plot No. 4 is third in productiveness, whil Plot No. 2 is last. This plot has produced the smallest number of flower throughout the experiment, but, as previously noted, it is douhtful if thi is the result of the fertilization.

A second mistake occurred February 1, 1911, when 27 grams of hig grade sulfate of potash was applied to each plot in the potash experiment This treatment was intended for anotber experiment.

The succeeding crop will, therefore, be of interest. This crop was cu during April and May, 1911.

An examination of the yields shows that all the plots have produced a large proportion of special grade flowers, and that all the plots are ver uniform when the total special and fancy grades of flowers produced b each plot is the basis of comparison. In total number of flowers cut, Plots No. 1 and No. 4 are equal, while Plot No. 3 is last. Crop 4 of the second season was cut from July 1st to August 4th, 1911, and the results are rela tively the same as those secured from Crop 3. The totals were as follows: Plot No. 1, 99 flowers; Plot No. 2, 87 flowers; and Plot No. 4, 91 flowers.

The no potash plot (Plot No. 1) has produced the largest number of flowers during the second season and bas also produced the greatest num *ber of flowers of the special and fancy grades. In fact, the total yield in*

these two grades is exactly the same as during the first season (240). This plot ranked second at the close of the first season and the 27 grams of high grade sulfate of potash applied by mistake during the second season may have made the difference. But if such was the case the yields show that the deficiency of potash was very slight. Plot No. 2 shows no gain over Plot No. 3 from the first season.

Third Season.

The same rose plants are seldom forced for more than two seasons by florists and new soil and new plants are commonly put in place of the old. The My Maryland plants in this experiment, however, were apparently as vigorous at the end of the second season as at the end of the first, and it was decided to keep them flowering for another year.

The soil in the bench, however, had settled until it was scarcely 3 inches in depth instead of 4 inches as at the beginning of the experiment. This was considered too shallow, as no mulch of any kind was being used; so after the fourth crop was cut at the close of the second season, two common pailfuls of soil was added to each plot to bring the surface of the soil about level with the top of the bench. This soil was similar to that used at the beginning of the experiment and consisted of red shale soil (Penn Loam) mixed with 10 per cent. sand and 20 per cent. of composted cow manure. The additional soil was placed upon the surface of each plot, as previously stated and was not dug into the old soil.

Ground limestone, acid phosphate, ground bone and dried blood were applied to each plot in the same quantities as at the beginning of the experiment.

The first crop of the third season was cut from the last of August to the first of October, 1911. This crop is the ninth that has been cut and recorded from these plants.

A comparison of the first crop cut from these plots at the beginning of the experiment with the first crop cut at the beginning of the third season shows that the vigor of the plants has been maintained upon all the plots. The total yield of all plots in the first instance amounts to 439 flowers, while in the last it amounts to 431 flowers. The yield of special and fancy grades, however, is considerably larger in the ninth crop than in the first crop. The plots continue to remain very uniform in general. For the ninth crop the plots receiving 1 gram of potash and 5 grams of potash respectively have produced a greater number of flowers of the special and fancy grades, while the plots receiving 2 and 5 grams of potash respectively have produced a somewhat larger total than the others.

The second crop of the third season was cut during November and December, 1911, and there was a marked falling off in vigor of the plants upon all the plots.

It was thought that the plants needed larger quantities of nitrogen, so the monthly application of concentrated tankage was increased from 27 grams per plot to 30 grams per plot on December 4, 1911, and this was later increased to 40 grams per plot on March 2, 1912. During this period

of a reduction in vigor, it will be noted that the plot receiving the 2 grams weekly has produced the largest yield, and that Plot No. 2, which has been lowest in yield in the past, now ranks second in quality and total production.

Even the increase in the application of the concentrated tankage to 40 grams did not bring about as much of an increase in vigor as was desirable, but without a previous test it was considered dangerous to further increase the amount of this material so an application of 227 grams per plot of cottonseed meal was made upon March 18, 1912, or 16 days after an application of 40 grams of concentrated tankage had been made per plot. Air slaked lime at the rate of 75 grams per plot was also added at this time. This brought about the desired increase in vigor and the yield obtained in the third crop in April and May, 1912, indicates this. The eleventh crop cut from the rose plants in this experiment was remarkable for its quality. Practically all the flowers had stems that exceeded 18 inches in length. For example, upon the plot receiving 2 grams of potash weekly, out of a total of 80 flowers cut, 21 had stems from 18 to 24 inches in length, while 54 had stems from 25 to 40 inches in length, leaving a total of only 5 flowers that had stems less than 18 inches in length. The total flowers cut upon all 4 plots for the third crop of the third season amounted to 308, while the total of the third crop of the first season was 312; and the result is really in favor of the former crop because it shows a greater proportion of special and fancy flowers.

These results indicate that the falling off in vigor during the winter of 1911-1912 was due to an insufficient supply of nitrogen and that the increase in the amount of tankage and the addition of the cottonseed meal supplied this need of the plants.

The lack of sufficient knowledge as to the safety limits of various chemical fertilizers such as concentrated tankage for roses in greenhouses led to the use of the cottonseed meal when the plants failed to make a proper growth even though it meant adding a very small quantity of potash as well as nitrogen. The latter material was believed to be safe to use in considerable quantities upon shallow greenhouse benches.

In the third crop for the third season the no potash plot produced the greatest total number of flowers and also the largest number of flowers of the special and fancy grades. The plot receiving 2 grams of potash weekly was practically as good, however, as it produced a far greater number of flowers of the special grade, although a somewhat smaller total of all grades.

The proportionately low yield cut from the plot receiving 5 grams of potash weekly is believed to be partly due to its location in the greenhouse.

The effect of the first application of cottonseed meal in addition to the tankage was so favorable that a second application of 113 grams per plot was made upon June 17, 1912. The plants continued to make a fine, vigorous growth and the fourth crop of the third season was cut during July and August, 1912.

In total flowers cut, the fourth crop of the third season or the twelfth crop of the experiment exceeds all others. It is also of high quality as is

indicated by the fact that 110 flowers with stems above 18 inches in length were cut from the plot receiving 5 grams of potash weekly. The plots receiving the higher amounts of potash have made a gain upon the other plots in this crop, and it is possible that such would have been the case earlier in the experiment if larger amounts of nitrogen had been used.

The total yields of all plots for the third season of the experiment (1911-1912) exceed those of the two previous seasons. The plot receiving the 2 grams of potash weekly has produced the largest yield during the third season. In total, the no potash plot and the one receiving one gram of potash weekly are practically tied for second place and the high potash plot ranks last. In total of special and fancy grades of flowers, however, the high potash plot is second. The latter plot fell behind the others in the second and third crops but appeared to improve after the 75 grams of air slaked lime were applied upon March 18, 1912.

After the fourth crop was cut at the close of the third season (August 20, 1912), 272 grams of ground limestone was again applied to each plot.

Fourth Season 1912-1913.

The rose plants were still apparently as vigorous at the close of the third season as they were at the end of the first or second, and they were kept growing continuously without drying off for the beginning of another season. Forty grams of concentrated tankage were applied to each plot monthly, but no additional cottonseed meal was applied after June 17, 1912, as previously recorded.

The first crop for the fourth season (1912-1913) was cut during October and November, 1912.

In this crop, Plot No. 5 has produced much the best total yield and by far the greatest number of flowers of the special and fancy grades. Plot No. 2 is second in the number of high grade quality flowers produced, but is last in total production. The additional lime applied March 18, 1912, may account for the relative increase in production by Plot No. 5 for the twelfth and thirteenth crops.

Table No. 4.

Total Yield of Roses Upon Potash Plots for Thirteen Crops.

TREATMENTS.	Special.	Fancy.	Extra.	Culls.	Totals.
No potash	307	467	340	60	1174
One gram	308	478	297	44	1127
Two grams	346	430	364	86	1226
Five grams	344	472	318	45	1179

Summary.

A summary of the yields obtained from the 13 crops cut from the potash plots from the time of benching, June, 1909, to the close of the thirteenth crop, November, 1912, is given in Table No. 4. The plot receiving 2 grams of potash weekly has during this time produced 47 more flowers than the plot which received 5 grams of potash, but this advantage amounts to but

very little when an examination is made of the yields as to grade. The plot receiving the 5 grams of potash has produced 2 more specials and 42 more fancys than the plot receiving the 2 grams and the latter plot has only 46 more extras than the 5 gram plot to set against it if we do not consider an excess of 41 culls upon the 2 gram plot. All things considered, the 5 gram plot has done equally as well as the 2 gram plot in total. If it were not for the fact that the 5 gram plot produced light crops in the middle of the third season, probably because of soil acidity, it would have undoubtedly produced as large if not a larger actual total than the 2 gram plot.

In the number of flowers of special grade the check plot and the one gram plot agree as closely as do the 2 and 5 gram plots, but in the number of flowers of the fancy grade the 1 gram plot excels by 11 flowers. The check plot produced the largest total, however, and makes the gain in extras and culls, the latter of which should perhaps be rather lightly considered.

The advantage of the high potash plots over the check and the 1 gram plots is largely confined to the special grade and the difference in a total of 13 crops is only a matter of about 3 dozen flowers. It should be remembered, however, that these results were obtained with a very small number of plants (15 in each plot), and that if proportionate results were secured with 1,500 or 15,000 plants the difference in yield would be of considerable account.

Yet the results for the first two years apparently indicate that a good red shale loam with 20 per cent. of composted cow manure contains sufficient potash to about supply the needs of My Maryland roses in continuous growth for two years even though 27 grams of high grade sulfate of potash was added to the no potash plot by mistake during these two seasons.

It is possible that a more liberal supply of nitrogen might have resulted in somewhat larger yields upon the high potash plots, yet, it is believed that the amount of potash required by roses of this type, for the first two years, in excess of that to be obtained in a good soil with at least 20 per cent. of composted cow manure, is very small. Some potash was added to the no potash plot during the third season in the form of soil added to the surface of the bench and in the 227 grams of cottonseed meal upon March 18, 1912, and 113 grams upon June 17, 1912, yet the amount of actual potash applied in this way was small. The plants upon this plot were able to maintain a good yield for more than three seasons with but very little additional potash than was actually supplied in the soil and the compost. Some fluctuations in yields occurred during the experiments but these are no greater than are to be expected under greenhouse conditions and it is believed that the differences between the plots were brought about more by conditions of environment than by the differences in fertilizer applications.

The results of the experiment indicate further, however, that relatively large amounts of potash in the form of high grade sulfate may be applied to roses without any danger of injury in the presence of sufficient quantities of lime.

The application of rather large quantities of potash did not apparently increase the color or the general quality of the flowers in these experiments. The color of My Maryland is largely determined by the factor of light and by rate of growth as reported previously.*

To make certain that sufficient amounts of potash are present in soils used for more than one season for the forcing of roses, it is suggested that florists might apply high grade sulfate of potash to their soils at the beginning of each season at the rate of 1200 grams per 200 cubic feet of soil, or about 3 pounds to 200 cubic feet. In terms of bench surface this will mean an application of 3 pounds of high grade sulfate of potash to 600 square feet, where the soil is 4 inches deep in the bench. In making this recommendation it is supposed that the florist will use a good loam soil composted with at least 20 per cent. of manure. Where no manure is used, larger amounts of potash might prove beneficial, especially where the same soil is retained for more than one season.

Where manure is applied to the benches, however, as a mulch and especially where liquid manures are also applied to the soil it would seem that liberal amounts of potash are commonly supplied to roses in general greenhouse practice.

A SOIL STUDY WITH MY MARYLAND ROSES.

The soil in the immediate vicinity of the New Jersey Experiment Station at New Brunswick, New Jersey, is of the type known as red shale, or Penn loam. It occurs in a considerable area across the state, and in still larger areas in Pennsylvania. This soil is similar to a clay in its behavior, being compact, dense and pasty when wet, and baking into hard lumps when dry. It is too compact and dense to be favorable to such crops as lettuce, spinach or even potatoes.

A strong loam, even a clay loam is commonly recommended to be the best type of soil for the culture of roses. From this point of view the red shale should be well adapted for rose culture. However, when floricultural investigations with roses were first undertaken at this station in 1908, it was considered important to know something definite as to the adaptability of the red shale, or Penn loam, soil for the forcing of roses in the greenhouse before undertaking plant food, or fertilizer investigations. With this point in view, the following soil test was conducted.

Red shale or Penn loam was collected in the form of sod in the fall of 1908, and placed in a pile to decay. This was then shoveled over the following spring, and the decayed sod made fine. The following soil mixtures were then prepared according to bulk: Red shale soil, red shale soil with 10 per cent. of sand, red shale soil with 20 per cent. of sand, red shale soil wih 30 per cent. of sand.

The experiment has been conducted in an even span greenhouse of iron construction, 33x18 feet. The center bench in the house was selected for the investigations, and is constructed with cypress sides, tile bottom and pipe legs, and is 4 inches deep. The bench was divided by board partitions

*Report of Society for Horticultural Science *1910*, pages 19-27.

into eight sections of 15 square feet for plots, with these soil mixtures: Plots 1 and 5, red shale soil; Plots 2 and 4, red shale with 10 per cent. sand; Plots 3 and 7, red shale with 20 per cent. sand; Plots 6 and 8, red shale with 30 per cent. sand.

As soon as the soil mixtures were prepared in June they were placed in the various sections and the following initial application of fertilizer was made to each plot: Nitrate of soda, 21 grams; acid phosphate, 204 grams; sulfate of potash, 54 grams; ground limestone, 272 grams.

Fifteen plants were set in the soil of each plot June 3, 1909, and made a good start upon all the plots. The growing shoots were pinched back whenever a bud set until the plants developed a good size. The object of this practice was to secure vigorous plants and flowers with good stems before any were cut.

The plants upon the different plots appeared uniform for several weeks when those upon the red shale plots began to show slight superiority, while the plants upon Plot No. 3 (red shale with 20 per cent. of sand) failed to make as rapid a start as the others. Beginning with the first of August each plot received 27 grams of concentrated tankage monthly. The first crop was cut from October 21, 1909, to November 22, 1909. The same method of grading was practiced as in the potash experiment previously discussed.

Plots No. 1 and No. 5, the red shale plots, produced more flowers than any of the other plots and the quality was fully as good. Plot No. 5 with 36 flowers of special grade and 61 flowers of the fancy grade yielded the best. From the results of more recent experiments the writer is inclined to doubt whether the advantage indicated by Plots No. 1 and 5 in this crop is due to the physical nature of the soil. Although 21 grams of nitrate of soda was applied to each plot just previous to benching and 27 grams of concentrated tankage was applied monthly beginning August 1st, it is possible that the advantage indicated by Plots No. 1 and No. 5 may be due to a greater percentage of available nitrogen. This theory is further strengthened by the fact that the shale and 10 per cent. of sand mixture (Plots No. 2 and No. 4) average next highest in yield to the shale plots. Plot No. 3 (red shale with 20 per cent. sand) has produced fewer flowers than Plots No. 2 and No. 4 upon either side of it, and that its duplicate (Plot No. 7) is also low in yield. Plot No. 8 is, however, lowest of all in both total number of flowers and in total number of flowers of the special and fancy grades.

The second crop of the first season was cut from December 23, 1909, to February 10, 1910.

The yields of the various plots in the second crop are much more uniform than in the first crop. Six plots out of eight show a total of from 70 to 79 flowers. The uniformity is still further pronounced in the number of flowers of special and fancy grade cut from each plot. The advantage shown by the red shale plots (No. 1 and No. 5) in the first crop disappears in the second, and the 30 and 10 per cent. of sand mixtures have a greater total yield. For some reason the 20 per cent. of sand mixture continues to be the lowest in yield.

The third crop was cut from March 25, 1910, to May 7, 1910. During the winter months the temperature in the greenhouse somewhat favored the plots at the west end. The My Maryland rose succeeds best when the night temperature does not fall much below 61 or 62 degrees. During cold nights especially, the temperature about Plots No. 6, No. 7 and No. 8 was somewhat higher than about Plots No. 1, No. 2 and No. 3, as the heating pipes enter the house from the west end. This does not cause a very pronounced variation in yield, but explains some of the differences indicated between duplicate Plots No. 1 and No. 5 and Plots No. 6 and No. 8 during the winter months.

The results of the third crop are not quite as uniform in general as in the second crop and this is probably due to the greater variation in greenhouse conditions during the winter months. The principal differences are between the duplicate plots of the red shale and the duplicate plots of the 50 per cent. of sand. Attention is called to the high quality of the flowers cut during this crop, as illustrated in Fig. 15. A large proportion are of the special grade with stems measuring from 24 to 40 inches in length with very few flowers with stems less than 18 inches in length.

The fourth crop of roses in this experiment was cut from July 1, 1910, to August 5, 1910.

Summary of the First Season.

The yields of each plot for the first four crops have been published so that the variations between the duplicate plots might be noted. It might be supposed that the results under greenhouse conditions should be more uniform than under field conditions, but observations show that such is not the case. By dividing greenhouse benches into sections and recording the yields of roses one is soon impressed by the variations which occur These variations are due to differences in the intensity of light in different parts of the greenhouse; to variations in temperature of air and soil; to variations in the air currents and possibly to other variable factors. These differences often balance, however, when the yields are recorded over a full season. Plants which rank low in production at one time may be high at another. Fluctuations in yields occur even under the most uniform conditions. This fact is also true with other plants such as apples, when a season of a low yield is usually followed by a high yield for the next season. And if a plot of roses has been held back slightly more than some other plot, because of a somewhat lower temperature, it is likely to do very much better proportionately when more favorable conditions occur a little later. These facts indicate the importance of check plots, properly distributed, in the greenhouse and rather extended tests before announceing results.

A summary of the results of the first season in the soil study with My Maryland roses will more fairly present the differences between the treatments and by averaging the yields of the duplicate plots a still better basis of comparison is obtained.

Table No. 5.

Average Yields of My Maryland Roses in Soil Study. (Four Crops). Season 1909-1910.

Grades	Red Shale	10 per cent sand	20 per cent. sand	30 per cent sand
Special	111	154	133	159 5
Fancy	120 5	112	101 5	104 0
Extra	83	61	55	64 5
Culls	1 5	1	1 5	1 0
Totals	346 0	328	291 0	329 0

The average yields upon the different soil mixtures for the first season of four crops are given according to grade in Table No. 5.

A comparison of the total average yields regardless of quality shows the red shale to be first with 346 flowers, the 30 per cent. of sand mixture to be second with 329 flowers, the 10 per cent. of sand third with 328 flowers and the 20 per cent. of sand last with 291 flowers. This in itself, however, is not a complete comparison, for when we examine the average total number of flowers of special and fancy grades produced upon each treatment we find that the 10 per cent. of sand mixture ranks first with 266 flowers, the 30 per cent. of sand second with 263.5 flowers, the red shale third with 261.5 flowers and the 20 per cent. of sand last with 234.5 flowers. The 10 per cent. of sand mixture and the 30 per cent. of sand mixture are practically equal. Both are slightly inferior to the red shale in total number of flowers for the season, but this difference occurs entirely in the first crop and is more likely to be a plant food question than one of soil. It is believed that the comparison is fair when these three soils are ranked as about equal for the first season.

Second Season 1910-1911.

At the beginning of the second season each plot in the experiment received 272 grams of ground limestone, 102 grams of acid phosphate and 27 grams of high grade sulfate of potash. The monthly applications of concentrated tankage at the rate of 27 grams per plot were continued during the second season.

The first crop for the second season was cut from September 16, 1910, to October 21, 1910.

There are several interesting features indicated by the results of this crop. Plot No. 5 and Plot No. 6 have produced exactly the same number of flowers. Plot No. 6 shows a slight superiority in quality, however. Plot No. 1 has commenced to fall below the others in yield. Plots No. 2 and No. 4 are very uniform, while Plot No. 3 again produces the lowest total yield of any of the plots. Plots No. 5, No. 6 and No. 7 are really about equal in the results of this crop.

Twenty-seven grams of high grade sulfate of potash was applied to each plot in the experiment February 1, 1911.

The second crop of the second season was cut from December 26, 1910, to February 13, 1911.

The results of the second crop are of interest as Plots No. 5 and 6 have again produced exactly the same number of flowers with the quality slightly in favor of Plot No. 6. Plot No. 1 is again low, and Plot No. 8 is again below its duplicate, Plot No. 6. These two end plots of the bench have somewhat less favorable situations than the other plots. Plot No. 3 in this crop is superior to either Plot No. 2 or Plot No. 4 and has thus advanced in relative standing.

The third crop of the second season was cut from April 13, 1911, to May 31, 1911.

The results of the third crop of the season are notable for their uniformity. All the plots except two have produced from 69 to 75 flowers, and with the exception of Plots No. 1 and No. 3 all the plots are very uniform in the total number of flowers produced of the special and fancy grades. Plots No. 5 and No. 6 have again produced almost the same total number of flowers. Plot No. 5 has produced one more flower, but Plot No. 6 has produced one more flower of special grade than Plot No. 5.

Plot No. 3 is again low in the quantity of flowers produced, although its duplicate, Plot No. 7, is practically equal to any other plot. Plots No. 4, No. 5, No. 6 and No. 7 are all very uniform. Attention should be called to the high grade of all the flowers cut during this crop. A large proportion in each case are of the special or fancy grade with very few extras.

Upon June 27th, 272 grams of ground limestone was added to each plot in the experiment and upon July 15, 1911, another application of 150 grams was made to each plot.

The fourth crop for the second season was cut during July and August, 1911.

Plots No. 5 and No. 6 remain very uniform in total production even in the fourth crop of the second season and Plot No. 6 has again the advantage in the number of high grade flowers. The 20 per cent. of sand mixture has produced well during this crop.

Table No. 6.

Average Yields of My Maryland Roses for Second Season 1910-1911.
(Four Crops).

Grades.	Red Shale.	10 per cent. sand	20 per cent. sand.	30 per cent. sand.
Special	126	149	143	171
Fancy	99	96	94 5	101
Extra	45.5	59.5	53 5	43 5
Culls	5 5	5 5	7 5	3
Totals	276 0	310 0	298 5	318 5

A summary of the results of the second season appears in Table No. 6. The 30 per cent. of sand has produced the largest average number of flowers, and by far the largest number of flowers of the special and fancy grades. The 10 per cent. of sand mixture ranks second, the 20 per cent. of sand is third, and the red shale soil is in last place. Plot No. 1 of this treatment fell off badly in production the second season, and if Plot No.

5 only was considered the shale would make a better showing in comparison with the other plots. It is apparent, however, that the sand mixtures are slowly improving their yields over the shale. The 20 per cent of sand mixture which was last at the end of the first season is now third.

Third Season—1911-1912.

The My Maryland rose plants were as vigorous at the close of the second season as they were at the end of the first and it was decided to continue the experiment for another year with the same soil and the same plants.

The first crop was cut during September and October, 1911, and the combined average total yields were 10 per cent. of sand, 102 flowers; 20 per cent. of sand, 94 flowers; red shale, 92 flowers; and 30 per cent. of sand, 89 flowers. Although the red shale plot produced two less flowers than the 20 per cent. of sand, it was slightly superior to it in quality.

The second crop of the third season was cut during November and December, 1911, and the combined average total yields were as follows: 20 per cent. of sand ranks first with 50 flowers; 30 per cent. of sand is second with 46 flowers; 10 per cent. of sand is third with 36 flowers, and red shale is last with 33.5 flowers. It will be noted that the 20 per cent. of sand mixture has gradually been improving in production in comparison with the other plots, while the red shale plot is falling back in production. Plot No. 5 (red shale), which maintained its place for some time after Plot No. 1 had begun to lose vigor, has now commenced to fall off rapidly in yield also. At this time the plants upon all the plots were declining in vigor. This was not remarkable perhaps as the same soil had been used continuously for two and one-half seasons, but an effort was made to see if the decline in vigor could not be remedied, and the monthly application of concentrated tankage was increased from 27 grams to 30 grams per plot each month beginning December 4, 1911. This did not have the desired effect so the amount was increased to 40 grams per plot upon March 2, 1912, and 227 grams of cottonseed meal was applied to each plot March 18, 1912. Seventy-five grams of air slaked lime was also applied to each plot at this time. The plants immediately responded to this treatment, and improved greatly in vigor.

The third crop of the third season was cut during April and May, 1912, with the following results in average total yields. The 20 per cent. of sand treatment was first with 82.5 flowers; the 30 per cent. of sand was second with 76 flowers; the 10 per cent. of sand was third with 70 flowers, and the red shale was last with 52.5 flowers.

The application of the cottonseed meal upon March 18, 1912, proved so beneficial that 113 grams of this material was again applied to each plot upon June 17, and the plants continued to respond with increased vigor. The fourth crop of the third season was cut from July 15th to August 22nd, 1912.

The fourth crop of the third season, or the twelfth crop since the experiment was started is by far the best in total number of flowers cut of any preceding crop except upon the red shale soil. Plot No. 5 no longer pro-

duces yields equal to Plot No. 6, but has, in fact, fallen much below it in production.

It is evident that its physical condition is not as suitable to the growth of the plants as at first. This is probably due to the gradual decay and loss of organic matter, for the soil has become very compact and stiff. Plot No. 3, which was decidedly low in yield at first is now only second to Plot No. 6 in total production. Plot No. 8 has fallen off in production during this crop and this will directly affect the rating of the 30 per cent. of sand mixture when the plots are averaged. As previously stated this is an end plot and is apparently affected by environment.

A summary of the four crops for the third season is given in Table No. 7.

Table No. 7.

Record of Total Yields of My Maryland Roses for Third Season. (Four Crops). 1911-1912.

Grades.	Red Shale.	10 per cent. sand.	20 per cent sand.	10 per cent. sand.	Red Shale.	30 per cent sand.	20 per cent. sand	30 per cent. sand
Special.......	94	109	98	98	86	132	101	103
Fancy........	109	142	166	133	99	147	162	125
Extra	64	76	91	91	69	62	75	70
Culls......	19	15	11	17	15	13	12	11
Totals....	286	342	366	339	269	354	350	309

The results indicated by the yields of the fourth crop are verified in the combined yields of the four crops of the third season. Plot No. 3 has produced the largest number of flowers (366), but Plot No. 6 has produced the largest number of flowers of the special and fancy grades, 279 in comparison with 264 upon Plot No. 3, so that these plots may be ranked as practically equal. Plot No. 6 also adjoins Plot No. 7, the duplicate of Plot No. 3, and is slightly superior to it. Plot No. 8, however, is low in yield, but this is probably due to its location as previously stated. Later results will also bear out this point. The red shale plots have dropped back permanently into last place. Earlier in the experiments some consideration was given to the fact that Plot No. 1 began to fall off in production and a comparison between the shale plots and other plots was largely made upon the basis of the results indicated by Plot No. 5, thus giving Plot No. 1 the benefit of the doubt that environment might have affected its yield. The total results of the third season, however, show that Plot No. 5 has produced less than Plot No. 1, and there is no longer any question that the red shale has become inferior to the sand mixtures.

All of the sand mixtures responded to the applications of cottonseed meal, and produced even better than in earlier crops, but the red shale plots were unable to do this.

Fourth Season—1912-1913.

The plants were apparently as vigorous at the end of the third season as in any previous year and they were kept growing without check or rest, and without any change of soil. Two hundred and seventy-two grams of ground

limestone were applied to each plot at the close of the third season and the application of 40 grams of concentrated tankage was continued each month. The thirteenth crop since the beginning of the experiment was cut from October 1st to November 11th, 1912.

The most notable result of this crop is the fact that it is the best crop that has been cut during the fall months of any year since the experiment began, or in other words the first crop of the fourth season is better than the first crop of any previous season. This fact does not hold true of the red shale plots, but it does with the other soil mixtures.

It is almost certain that some of the crops of the first and second years would have been larger if more nitrogen, in the form of chemical fertilizers, had been applied at that time, but this does not detract from the fact that these roses have been maintained in a vigorous and profitable condition for more than three years without the use of manure of any kind.

An average of the total yields for the thirteenth crop gives the following results: red shale, 84 flowers; 10 per cent. sand, 117 flowers; 20 per cent. sand, 123 flowers; and 30 per cent. sand, 131.5 flowers. This is the first crop in which the average total yields rank in regular sequence with different proportions of sand.

The 20 per cent. of sand mixture which was unaccountably poorest at the beginning of the experiment has established its position close to the top in rank as to yield. Plot No. 8, which fell off in yield during the latter part of the third year, again produced well in the thirteenth crop, which is probably more nearly its proper behavior.

The total yields upon all the plots for the thirteen crops are of interest, and are given in Table No. 8.

Table No. 8.
Record of Total Yields of My Maryland Roses for Thirteen Crops.

Season.	Red Shale.	10 per cent. sand.	20 per cent. sand	10 per cent sand	Red Shale	30 per cent sand	20 per cent. sand.	30 per cent. sand
1909-1910 . .	330	341	288	315	362	339	294	319
1910-1911. .	230	312	271	308	322	329	323	318
1911-1912.	286	342	366	339	269	354	350	309
1 crop '12-'13 .	74	113	129	121	94	137	117	126
Totals . .	920	1108	1059	1083	1047	1159	1084	1072
Aver. yields	983.5	1095.5	1070.5	. . . .	. . . .	1115.5	. . . .	. . . .

Plot No. 6 has produced the largest number of flowers of any single plot during the experiment and the average production of this plot and its duplicate (Plot No. 8) is greater than the average production of any other soil mixture. Plot No. 2 ranks next to Plot No. 6 in total production of any single plot, but it owes its place to the yield produced the first season. Both the red shale plots are lower in yield than any other treatment.

According to average total yields the 10 per cent. sand mixture takes rank over the 20 per cent. of sand mixture. This result is due to the fact that the 20 per cent. of sand mixture, especially in the case of Plot No. 3, failed to produce well for the first two seasons. Since that time it has

gained steadily upon the 10 per cent. of sand mixture and would undoubtedly establish a combined total greater than the 10 per cent. of sand mixture if further crops were recorded.

The results secured in the thirteenth crop have come about very gradually, but are believed to indicate the true conditions.

Conclusions.

From the results of this experiment, conducted over a period of more than three years, it would appear that heavy or stiff soils, such as the red shale or Penn Loam gradually lose their organic matter under culture in the greenhouse and may become unfavorable to roses unless more organic matter is added.

Some varieties of roses apparently succeed equally as well upon a soil containing a large proportion of sand as upon a heavy clay loam soil. It is possible to maintain rose plants in a vigorous and profitable condition upon the same soil for at least three seasons without resorting to the use of animal manures.

It should not be inferred from these results that the red shale soil with 30 per cent. of sand is the best soil mixture for all varieties of roses. It is possible that additional organic matter in the form of manure, or some other material, would prove beneficial after the first or second season, especially from the standpoint of increasing the water holding capacity of the soil.

The proper watering of the rose plants in the greenhouse is a very important factor in successful rose culture. The plants should not be allowed to become dry and then be deluged with water. Where roses are grown upon raised benches in not more than 4 inches of soil there is danger of the soil drying out so rapidly at certain seasons of the year that the plants may be checked. This is one of the reasons why a mulch of manure is kept upon the surface of the bench. It greatly reduces the time required to keep the soil properly wet, and lessens the danger of the plants becoming too dry at any time, or in other words a certain soil mixture may prove very successful if it is kept properly wet, but it may dry out so rapidly that it is difficult to keep it in the proper condition and thus a soil with more organic matter or greater water holding capacity might be more practical and profitable. Further experiments which are being conducted seem to establish this point.

To secure maximum crops from a bench of roses it is necessary for the soil to remain in a mellow, spongy condition that is favorable to root development for its entire depth. If from lack of organic matter or too little sand, it becomes too compact or pasty the plants deteriorate.

GENERAL CONDITION OF FRUIT CROP IN STATE.

The past season was the most favorable for fruit crops in New Jersey that has occurred for a number of years. The set of fruit upon apples, pears, peaches, plums, cherries, grapes and strawberries was nearly maximum upon orchards properly located and well managed.

In a few localities, such as Vineland a sudden fall in temperature upon March 21 destroyed many of the peach buds in orchards that were located at elevations not above the average for the locality.

The set of fruit throughout the State upon young peach trees two to three years of age was unusually heavy and a considerable proportion of this remained upon the trees and matured. In ordinary seasons such trees would have made so rapid a growth that the fruits would have fallen in June. That they did not do so in 1914 was due to weather conditions.

A period of dry weather prevailed directly after the blooming period and seriously affected the strawberry crop in southern New Jersey in the latter part of May and early June. The drought was not severe enough to stop the growth of well cultivated peach trees, but it undoubtedly reduced the amount of growth.

In many orchards not a single peach dropped at the usual time, except those actually injured in some way. Later in the season, however, after rains occurred, and the peaches had reached considerable size a belated June drop occurred.

Small Size of Fruit.

There was much complaint that peaches were small at maturity. This was undoubtedly due in a considerable degree to the heavy set of fruit and weather conditions.

In 1913 the cold weather immediately following the early blooming period had the effect of checking growth and encouraging increased size of fruit.* In 1914, the blooming season was late and even though there was a light rainfall in May and early June, which checked growth to some degree, good growing conditions followed this period and trees grew rapidly.

The strawberry crop, especially in southern New Jersey, was greatly reduced by the drought except where the fields were irrigated.

The quality of the apple crop throughout the state was especially good where systematic spraying and cultivation were practiced. Currants in many instances failed to set fruit well and the berry clusters were irregular and not filled out.

Observations Upon the Stems of Apples.

The stems of apples receive comparatively little attention from fruit growers and horticulturists except in identification of varieties, packing of fruit, and in judging fruit at exhibitions. But in all of these instances the form and length of the stem is of considerable importance. Certain varieties are more or less distinct from others because of the extra length of the stem of the fruits. Rome, for example, has a characteristically long slender stem, while Roxbury Russet and Newtown Pippin have short stems. In the packing of fruit in boxes, the short stemmed apples are more desirable than long stemmed ones, as it greatly lessens the danger of stem bruises or punctures, and in some cases it is almost impossible to prevent some stem bruises in the packing of such varieties as Rome.

*N. J. Expt. Sta. Rpt. 1913, p. 118.

FIGURE 17.—Showing failure of currants to set on stems of some varieties the past season.

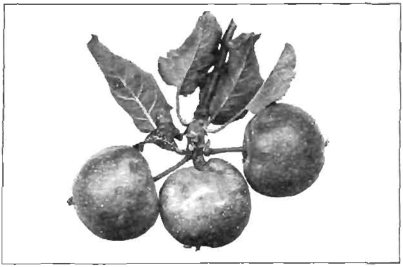


FIGURE 18.—Cluster of King Apples showing marked variation in form and length of stems.

FIGURE 19. Cluster of King Apples. The *right side of the cluster was hanging toward the tree itself when the cluster was cut off for photographing.*

FIGURE 20.—Cluster of Baldwin Apples where the central apple failed to develop properly.

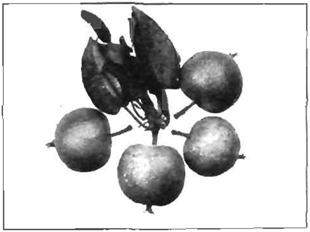


FIGURE 21.—Apple cluster of King.

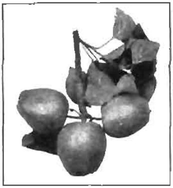


FIGURE 22.—Apple cluster of Chenango.

FIGURE 23.—Apple cluster of Barry.

It is in the judging of fruit, however, that differences of opinion in regard to the proper form and length of stem for any variety arises. The term "form" appears upon every score card designed for the judging of apples. And this term as interpreted by most judges includes the shape and length of the stem and the form and depth of the cavity and basin of an apple, as well as its general outline. In fact variations in the stems of apples of any single variety are more or less associated with variations in the form of the cavity and sometimes of the whole apple itself.

Most judges will agree that an apple receiving a perfect score for form should be one that is exactly typical in shape for the variety. This is where the difficulty arises, because there is considerable variation within the variety and this variation is not confined to the outline of the apple as a whole but also extends to the stem.

The Baldwin, for example, may have a short, thick stem and a narrow, abrupt cavity in some cases, and a long stem with a much wider and less abrupt cavity in other specimens. This variation is also quite common with Tompkins King and many other varieties.

If we are to judge the form of an apple including the character and length of stem according to the true botanical type for the variety, the question then arises why do we have Baldwin apples with different types and lengths of stems, what causes the variation and which is the normal type?

Observations of a number of varieties of apples growing at the New Jersey Agricultural Experiment Station in July, 1914, revealed the following: Wherever five apples had set in a single cluster upon King the center apple of the cluster, or the one directly opposite the end of the spur upon which the cluster was borne invariably had a short thick stem. In some cases the stem was even decidedly lipped as illustrated in Fig. 16. The apples surrounding the central one of a cluster always had longer and more slender stems than that specimen.

A further study of the matter shows that this behavior is not unusual. A normal fruit bud upon the apple commonly develops five flowers and the central one of these, if uninjured, blooms and sets fruit in advance of the others. If conditions continue to be favorable, this fruit will be the largest one in the cluster for some time.

The foliage and flowers of the higher forms of plants are arranged so as to secure the greatest possible exposure to light. In the family Umbelliferae the stems of each individual umbel making up an entire flower is of such length that all the flowers are in about the same plane. This means that the stems of the marginal umbels must be longer.

In most varieties of apples at least there seems to be an attempt to have all the apples of a cluster in the same plane and this requires the apples surrounding the central one to have longer stems as illustrated in Figs. 17, 20, 21, 22 and 23. It is evident, too, that in a cluster of apples hanging downward on a slender twig, one or more apples will be located toward the trunk or center of the tree, while others will be on the side of the cluster fully exposed to the light. It might be expected, then, that the

apples located on the side of the cluster facing the center of the tree would have somewhat longer stems than those on the fully exposed side, and this is often the case as shown by the illustration of a cluster of King apples in Fig. 16. The cluster hung downward from the tip of a branch and the side of the cluster at the right of the picture was toward the trunk of the tree and thus less exposed to the light.

When the central apple of a cluster fails to set, the remaining apples have stems of a more uniform length, as illustrated in Fig. 20. Figs. 19, 20, 21, 22, and 23 illustrate clusters of apples of King, Chenango, Barry, King David, Yellow Transparent and Gravenstein and in all cases the center apple of the cluster has a shorter and thicker stem than the others.

This is also associated with differences in form between the apples. The Roman Stem apple is thus named because many of the specimens have stems that are more or less lipped and yet even with this variety the central apple of a cluster of five has this character developed to a more pronounced degree than the others.

It can be noticed in Fig. 19 that the central apple of the cluster is more roundish oblong and less roundish conic than the others. Again in Fig. 21 the central Barry apple is much less ribbed than the others. The stems of Gravenstein appeared to vary less than some other varieties, yet instances occurred.

The form of an apple including the length and thickness of the stem is, therefore, determined to a considerable extent by its location upon the tree. This applied particularly to such varieties as Baldwin, King, Chenango, Barry, King David and undoubtedly to other varieties not observed by the writer. Gravenstein, Smith Cider, Rome and Ben Davis show a much greater degree of uniformity in form and length of stem.

In some seasons such varieties as Baldwin would have a larger proportion of short or long stemmed apples depending upon the weather, or according to whether the central apple of a cluster set and persisted, or failed to do so. Botanically, the short stemmed Baldwin or King as grown in New Jersey is just as typical as the long stemmed specimens and vice versa, so if we judge apples upon that basis it would seem that a somewhat liberal score for form should be allowed in judging such varieties.

BEHAVIOR OF VARIOUS VARIETIES OF FRUIT IN NEW JERSEY.

During 1913 just as an extension department was being established, a series of blanks were sent to fruit growers requesting them to express their opinion as to the relative commercial merits of the various varieties of fruits as grown by them. A large total number of times a variety is reported may not indicate its popularity. It may only indicate that the variety has been widely planted. For example, 67 growers reported on the Smith Cider apple, while only 53 reported on Stayman Winesap. The Smith Cider is ranked *fair* by 30 growers and poor by 21, while Stayman Winesap is ranked good by 46 growers, fair by 5 and poor by none.

New or little known varieties are reported by only a few growers, and yet may be highly regarded. English Codlin is reported by 8 growers,

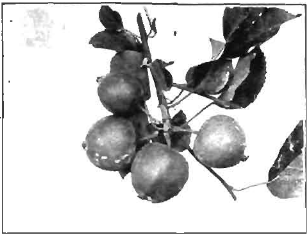


FIGURE 24.—Apple cluster of King David

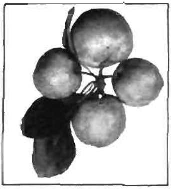


FIGURE 25.—Apple cluster of Yellow Transparent.

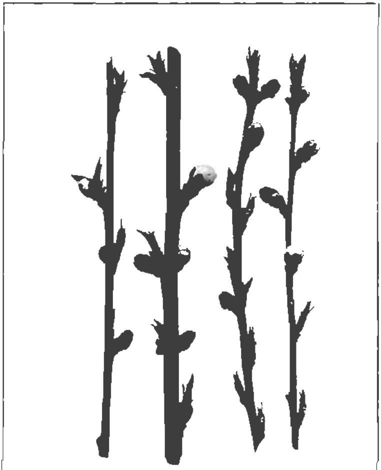


FIGURE 26.—Large and small buds of Slappey Peach

yet all rate it as good. Growers occasionally report upon a variety that is not true to name so that a single favorable or unfavorable report should not be considered as definite evidence.

The first 10 varieties of apples, listed according to the number of favorable reports, are Yellow Transparent, Wealthy, Stayman, Grimes, Gravenstein, Baldwin, Rome, Duchess, Williams and Maiden Blush. It is certain that when some of the young orchards come into bearing varieties like McIntosh and Arkansas or Paragon will be reported more frequently.

Only 7 varieties of pears were reported by 15 or more growers, and in number of favorable reports they rank as follows: Bartlett, Kieffer, Seckel, Duchess, Lawrence, Anjou and Clairgeau. Thirty-one growers report Kieffer as fair, however, and 11 as poor; 7 report Lawrence as poor and only 7 out of 17 report Clairgeau as good.

The first 10 varieties of peaches in total number of favorable replies are Elberta, Belle, Carman, Champion, Iron Mountain, Fox, Stump, Late Crawford, Mountain Rose and Old Mixon. *Growers should note, however,* that 26 growers report Mountain Rose as only fair and 6 as poor. Fifteen growers report Stump as only fair and 5 as poor. Thirteen growers report Champion as only fair and one as poor; nine growers report Late Crawford as fair and 8 as poor. These varieties were reported by a large number of growers, because they are widely distributed, but the reports indicate that they are lacking in certain commercial qualities. In comparison, note that out of 75 reports on Elberta, 71 declare it to be good, and out of 52 reports upon Belle, 50 declare it to be good. Lola is only reported by 22 growers, but 19 of these rate it as good.

Only 5 varieties of Japanese plums were reported upon, and Burbank and Abundance outrank all others. Among the European varieties Green Gage leads. Montmorency (Ordinaire) and Early Richmond are preferred as varieties of sour cherries, while Black Tartarian, Yellow Spanish, Napoleon and Windsor have received many favorable reports as sweet varieties. Fay, Wilder, Red Cross and Perfection rank well as varieties of currants, while Cuthbert, Ranere and Welch are preferred among the red raspberries. Cumberland and Plum Farmer are reported as good varieties of black-caps and Ward and Eldorado as leading blackberries. Concord, Niagara and Moore's Early have been quite generally reported as good varieties of grapes. Orange and Champion out-class all other quinces in the number of reports, and Houghton and Downing hold a similar place among gooseberries.

Reports upon Varieties by Growers.

Details are as follows: The first number indicating those "good;" the second "fair," and the "third" poor:

APPLES—Yellow Transparent, 49, 13, 4; Wealthy, 48, 4, 1; Stayman Winesap, 46, 5, —; Grimes, 40, 12, 2; Gravenstein, 40, 4, 1; Baldwin, 37, 26, 10; Rome, 37, 9, —; Duchess, 34, 12, 2; Williams, 34, 3, 1; Maiden Blush, 33, 24, 2; York Imperial, 33, 18, 5; Starr, 30, 1, 4; Astrachan, 29, 24, 8; Ben Davis, 27, 32, 14; Winesap, 26, 12, 3; Fall Pippin, 24, 9, 7; Arkansas or Paragon, 21, 11, 3; Smokehouse, 21, 8, 1; Jonathan, 20, 6, 2; McIntosh, 19, 3, 1; Nero, 18, 7, 4; Twenty Ounce, 19, 4, 1; Smith Cider, 16, 30, 21; Delicious, 13, 2, —; Stark, 15, 17, 2; White Pippin, 10, 3, —; Nyack Pippin, 9, 4, —; English Codlin, 8, —, —; Hagloe, 6, —, —; Winter Banana, 5, 3, 2; Pennock, 4, 1, —; Orange Pippin, 3, 4, 1; R. I. Greening, 3, —, —; *King, 3, —, —; Henry Sweet, 3, —, —; Northern Spy, 2, 2, 1; Ohio Nonpariel, 2, 1, —;* Sour Bough 2, 1, —; Fanny 2, 1, —; Fallawater, 2, 1, —; Cooper, 2, 1, —; Hubbardston, 2, —, — Newtown, 2, —, —.

PEARS—Bartlett, 58, 6, 3; Kieffer, 32, 31, 11; Seckel, 28, 13, 4; Duchess, 15, 10, 2; Lawrence, 10, 8, 7; Anjou, 9, 5, 1; Clairgeau, 7, 6, 4; Bosc, 4, 3, 2; Clapp's Favorite, 4, —, —; Le Conte, 3, 2, —; *Sheldon*, 3, 1, 1; *Manning's Elizabeth*, 2, 2, 1; *Louise Bonne*, 1, 4, 3; Wilder, —, 4, 1; Allentown Belle, 1, —, —; Winter Nelis, —, —, 4.

PEACHES—Elberta, 71, 3, 1, Belle, 50, 2, —, Carman, 49, 6, —; Champion, 47, 13, 1; Iron Mountain, 39, 8, 4, Fox, 38, 7, 1, Stump, 33, 15, 5. Late Crawford, 33, 9, 8; Mountain Rose, 31, 26, 6, Old Mixon, 29, 19, 5, Lola, 19, 3, —, Greensboro, 15, 11, 4; Hiley, 15, 6, —; Stevens, 14, 8, 7, Waddell, 11, 3, 3, Early Crawford, 11, 9, 14; Ray, 8, 4, 1; Reeves, 6, 1, 1; Salway, 5, 6, 3; Edgemont, 5, 5, 1, Smock, 4, —, —, Niagara, 3, 5, 3; Connetts, 3, 1, 1, Mt Rareripe, 2, 1, —; Keyport White, 2, —, —; Matthew's Early, 2, —, —; Frances, 1, 4, 2; Mayflower, 1, 1, —, Success, 1, 1, —, St John, 1, —, 1

PLUMS—Japanese: Burbank, 26, 4, 3; Abundance, 20, 7, 7; Red June, 9, 5, 1; Wickson, 6, —, 9; Chabot, 3, 4, —; European: Green Gage, 16, 2, 3, Lombard, 6, 2, 3; Shropshire Damson, 1, 2, 7; German Prune, 3, —, —, Bradshaw, 3, —, —; Imperial Gage, 2, —, —; *Fellenburg*, —, 1, 2.

CHERRIES—Sour: Montmorency (Ordinaire), 45, 1, —; Early Richmond, 37, 12, —; May Duke, 9, 4, 3. Sweet: *Black Tartarian*, 22, 3, 1; *Yellow Spanish*, 14, 2, 1; Napoleon, 10, 3, 1; Windsor, 9, —, 2; Gov. Wood, 3, —, —; Mercer, 2, —, —.

CURRANTS—Fay, 22, 1, —; Wilder, 9, —, —; Red Cross, 7, 2, —; Perfection, 6, 1, —; Pomona, 2, 3, 2; Cherry, 2, —, —; Versailles, 1, 1, —.

RED RASPBERRIES—Cuthbert, 27, 7, 2; Welch, 9, 3, 1; Ranere (St. Regis), 16, 5, 1; King, 5, 1, —, Herbert, 2, —, —; Miller, 1, —, 1.

BLACK CAPS—Cumberland, 12, —, 1; Plum Farmer, 10, 1, —; Kansas, 7, 3, 2; Gregg, 4, —, —.

GRAPES—Concord, 46, 1, 3; Niagara, 30, 5, 1; Moore's Early, 20, 5, 1; Delaware, 10, 2, 1; *Brighton*, 8, 1, —; *Worden*, 7, 8, 1; *Moore's Diamond*, 6, 3, 1; *Caco*, 2, —, —; Catawba, 2, —, —; Campbell's Early, 2, —, —; Ives, 1, 1, 1; Lady, 1, —, 1.

QUINCES—Orange, 22, 2, —; Champion, 14, 2, 2; Bourgeat, 4, —, —; Rhea Seedling, 3, —, —; Van Deman, 2, —, —.

GOOSEBERRIES—Houghton, 25, 2, —; Downing, 22, 3, 1; Columbus, 4, 1, —; Red Jacket, 3, —, —; Industry, 2, 2, 3.

BLACKBERRIES—Ward, 22, 2, —; Eldorado, 16, 1, —; Kittatinney, 11, 2, —; Erie, 4, 1, —; Blowers, 2, 5, —; Lawton, 2, —, —.

DEWBERRIES—Lucretia, 17, 1, 2; Austin, 2 — 1.

PEACH TREES INJURED BY POULTRY.

Poultry and fruit production are often suggested as two lines of agricultural effort that might well be combined with profit. No attempt is made at this time to discuss the merits of the matter. An experience at the College Farm is simply reported as it occurred.

An acre of land was fenced as a run for growing chicks. Peach trees were set 18x18 feet apart in the spring of 1912 to furnish shade and additional profit. The trees grew well during 1912 and 1913, and were not interfered with by the poultry. By the summer of 1914 the trees became of considerable size, and a flock of Leghorns confined in the enclosure began to roost in the trees. The damage was brought about by the young fowls flying from the tops of the coops into the tops of the trees, and attempting to climb to the tips of the branches. The trees were making rapid growth, and the tips of the branches were broken down by the fowls. It is not likely that this would have occurred if the coops could have been placed at a considerable distance from the trees. While the chicks were small no difficulty was experienced.

SOME STUDIES WITH PEACH POLLEN.

During the spring of 1913 Mr. Charles Miller, a senior student in Rutgers College, made some germination tests with peach pollen as a senior thesis. The results of his studies were published in the annual report of the Station for 1913.

Other questions of scientific interest arose following Mr. Miller's work and these were investigated by Mr. Howard F. Huber, a senior student

in Rutgers College in 1914. The following results were obtained by him and presented as a senior thesis.

Before making comparative studies with pollen from different sources it was necessary to find a medium which was best suited for the germination of the pollen grains. As a preliminary part of the work several solutions were tested in February, with pollen from blossoms upon two year-old seedling trees that had been forced in the greenhouse. The following solutions were tested; a synthetic medium used for growing fungi, made according to the formula, water-1,000 c. c., agar-15 g., glucose-20 g., dipotassium phosphate-0.25 g., magnesium sulphate-0.25 g., a solution containing 10 per cent. dextrose by weight, one containing 15 per cent. and another containing 20 per cent.; solutions containing 10 saccharose and 1 per cent. gelatin, and 15 per cent. saccharose and 1.5 per cent. gelatin.

The method followed was to put a small drop of the liquid on a cover glass, shake some pollen on it from one flower, and invert over a Van Tieglien cell containing water. After twenty-four hours this hanging drop was examined with the microscope; the total number of grains counted, the number that had germinated noted, and from these the percentage of germinations was computed. Pollen from four to six blossoms was tested each time with each medium, and as the tests were repeated, a sufficient number of blossoms were secnred to check any great variation between individual flowers. Of the solutions tested at this time, that containing 15 per cent. saccharose and 1.5 per cent. gelatin proved to be the best and it was selected for use in the later work.

In March twigs from several varieties were cut from the State Experiment Station Orchard at Vineland and forced into bloom in the greenhouses at New Brunswick. The buds were dormant when cut but in 18 days they were blooming, and they were tested on March 19 and March 20. It was decided to try the effect of an acid medium on the germination of the pollen grains, so a few drops of H_2SO_4 were added to the 15 per cent. saccharose and 1.5 per cent. gelatin solutions. This proved to be harmful, for an average of only 41 per cent. with six varieties was obtained. The solution was then sterilized in an autoclave at a pressure of 15 pounds for the purpose of storing for future use. The gelatin liqnified, and when the solution was tested again, two days later, it gave 65 per cent. germination with six varieties, four of which had been used in the first test.

Some of the 15 per cent. saccharose and 1.5 per cent. gelatin medium without H_2SO_4 was prepared at the same time (March 20) and when this was tested it averaged 77 per cent. with eight varieties. The varieties were tested again five days later, on March 25, but the flowers had begun to dry up, and it was impossible to secure a better average than 56 per cent. This work confirmed our choice of the 15 per cent. saccharose and 1.5 per cent. gelatin for use in this work, and in all later operations nothing else was used.

Observations Upon the Variability of the Pollen From Individual Blossoms.

Considerable variation was noticed in the viability of pollen from different blossoms of the same variety even when cut from the same twig,

so tests and counts were made with a view to finding out how great this variation might be. This was done in connection with the tests of the various media, and the pollen from each blossom was tested in two hanging drops of medium, and the results averaged together. In using the acid medium the variability was very great. Pollen of the Wonderful variety ran as low as 9 per cent. and as high as 77 per cent. Mountain Rose tested from 12 per cent. to 76 per cent. and Mayflower from 0 per cent. to 46 per cent. With the other medium the greatest variability was found in Reeve's Favorite, which ran from 57 per cent. to 93 per cent. Four of the varieties had a range of less than 15 per cent. with four blossoms in the test and of these Elberta had a difference of only 3 per cent. between 4 blossoms. Both Greensboro and Elberta tested 99 per cent. germination in individual cases. Considerable variation in viability is noted between different blooms upon the same tree in certain cases, while in others the results show quite general uniformity. Aside from variation in actual development of the bud, it is evident that weather injuries might also cause variation in the viability of the pollen in different buds.

Table 9.

Variation in Viability of Peach Pollen from Different Blossoms from same Tree.

(Tests made with 15% Saccharose, 1 5% Gelatin, Trace $H_2 SO_4$)

No. of Blossoms.	Mt. Rose.	Wonderful.	Early Crawford.	Greensboro.	Elberta.	Mayflower.
1.	28%	39%	27%	93%	61%	46%
2.	22	39	41	....	3	...
3.	76	9	15	....	50	18
4.	67	41	....	....	9	2
5.	12	22	...	....	....	....
6.	60	14	....	....	....	....
7.	33	28	....	....	....	....
8.	50	77	....	....	....	....
Average.	44%	33 37	27.87	93	30.75	16 5

(Tests made with 15% Saccharose, 1.5% Gelatin, No $H_2 SO_4$)

No. of Blossom.	Mt. Rose.	Wonderful.	Early Crawford.	Greensboro.	Elberta.	Mayflower.	Carman	Reeve's Favorite.
1.	65%	99%	50%	85%	96%	39	88%	79%
2.	92	88	41	97	96	36	93	93
3.	76	75	55	98	99	52	92	57
4.	86	81	45	99	98	38	94	73
Av.	79 7	85 7	47.7	94.7	97.2	41 2	91.7	74

Table 10.

Relation Between Size of Bud and Viability of Pollen.

Variety and size of bud.	1st Test.	2nd Test.	3rd Test.	Average.
Frances-Large	32%	35%	44%	37%
Frances-Small	70	21	18	36
Dewey-Large	83	37	31	50
Dewey-Small	87	65	77	76
Slappy-Large	82	24	41	49
Slappy-Small	95	62	55	71

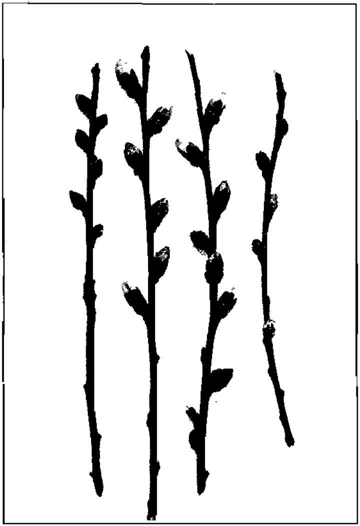


FIGURE 27.—Large and small buds of Dewey Peach cut from same tree.

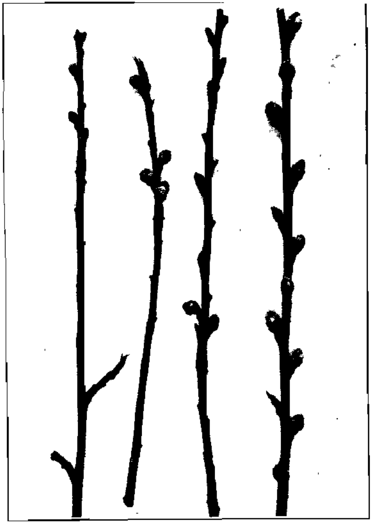


FIGURE 28.—Large and small buds of Frances Peach

Tests to Determine Variation in Viability of Pollen From Large and Small Buds on Same Tree.

It was thought that possibly there might be some relation between the size of the bud and the vigor of the pollen. So twigs of Slappy, Dewey, and Frances were selected, some bearing large buds, and some bearing small. Composite samples were taken of each, and it was found that with Dewey the small buds gave 26 per cent. and with Slappy 22 per cent. better germination than the larger buds. In the case of Frances the larger buds were one per cent. better than the smaller buds. The results indicate that there may be marked variation in viability of pollen between large and small flower buds upon the same tree.

Both large and small buds are found upon the same tree due to variation in bud development. If we examine the fruit buds upon a vigorous twig of the previous season's growth, it will be noted that those at the base of the twig are smallest with an increase in the size of the buds located near the center of the season's growth, but toward the tip of the twig the buds again commonly decrease somewhat in size. The fruit buds near the tips of vigorous twigs are commonly formed later in the season than those near the center of the season's growth, and are not as advanced in development when winter occurs and bloom later in spring. Buds upon vigorous twigs which have been checked slightly in growth are commonly large and in an advanced stage of development in the late fall, while buds upon nursery trees or late growing twigs upon bearing trees are smaller and developed to a less degree.

But aside from large and small buds upon the same twig due to variation in time of development and food supply, small buds may be found upon weak twigs and the small size of these buds is undoubtedly due to a lack of nourishment and vigor in the twig itself. It is probable that small buds from vigorous twigs would show a higher percentage of pollen germination than buds from weak twigs, and this is indicated to some extent by the results in these tests. The small buds of Dewey and Slappy were on quite vigorous twigs and the pollen germination was better than that of the large buds. The small buds in the Frances test, however, were from twigs that were very weak in vitality and the pollen failed to germinate well in the last two tests.

Effect of Moisture Upon the Keeping Qualities of Pollen.

It is an established fact that continued damp, rainy weather during the blooming season diminishes the set of fruit. This may be the result of washing away of the pollen; to injury to the pistil or to the fact that insects are kept from visiting the flowers. A large part of the damage may also be caused by the effect of the weather on the pollen, which deteriorates more rapidly under moist conditions than under dry. To show this fact clearly, samples of pollen were taken from a Belle of Georgia tree on May 6. They tested 56 per cent. germination. Then half the pollen was put in an unstoppered vial, and half was put in a vial plugged with a wad of moist filter paper. On May 7th the two samples were tested again.

The pollen in the open vial averaged 56 per cent., but that in the closed, moist vial gave only 11 per cent. When tested again five days later the dry pollen gave 4 per cent. germination, while the moist pollen was so mouldy that it could not be tested.

Viability of Pollen From Flowers Forced Into Bloom in Greenhouse.

A question of some practical importance to the scientific investigator is whether forcing peach buds to blossom during the dormant season by bringing them into the greenhouse has any effect upon the vitality of the pollen. Seedling peach trees brought into the greenhouse in the early winter came into bloom about Feb. 25 and pollen from these was used in the media tests as previously noted. Where a 15 per cent. saccharose and a 1.5 per cent. gelatin medium was used, the percentage of germination ranged from 75 to 80 per cent.

Twigs were also cut in March, and forced into bloom so that samples of pollen could be taken from March 18 to 25. The same varieties in the orchard did not bloom until April 20 to 30. Some samples were taken as late as April 14, when the buds were just beginning to show color, and others were taken April 18. In three cases, with Greensboro, Carman, and Mountain Rose the flowers forced out in the greenhouse gave better results than those that bloomed normally out of doors. Mayflower and Early Crawford showed a higher per cent. of germination in the late cut beds.

For some reason the pollen from the buds secured April 14 did not germinate well, which somewhat effects the completeness of the observations. However it is evident that pollen of good vitality can be obtained from peach buds forced into bloom a month or two in advance of the normal season of blooming.

VINELAND PEACH EXPERIMENTS.

The State Experiment Peach Orchard at Vineland was favored with another successful season during the past year. The usual heavy set of fruit buds occurred during the fall of 1913 and passed the winter months of December, January and February without much injury. On the date of March 21 a most unusual and sudden fall in temperature occurred in the vicinity of Vineland and a minimum of 6 degrees Fahrenheit was reached. Peach buds had swelled almost to the bursting of the bud scales by March 21, and it was remarkable that the crop was not entirely destroyed.

Orchards located at the lower elevations about Vineland suffered severely. Orchards upon the higher elevations, however, produced from a fair to a good crop of fruit. The effect of slight differences in elevation was most marked even in the same orchard.

The experiment orchard suffered slightly from the effects of this severe fall in temperature, but the injury was largely confined to the northeast corner of the orchard and to susceptible varieties such as Reeves. This season gives emphasis to the objections to such varieties for planting in New Jersey.

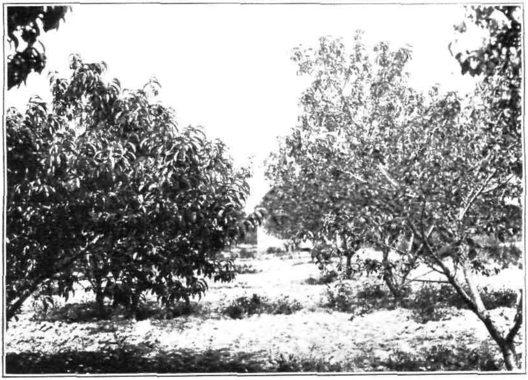


FIGURE 29.—Sprayed and unsprayed Belle Peach trees at Vineland.

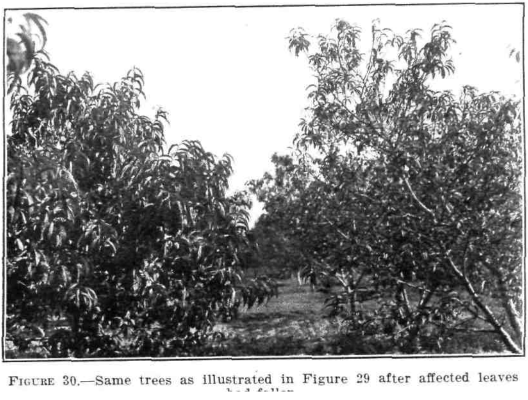


FIGURE 30.—Same trees as illustrated in Figure 29 after affected leaves had fallen.

Crop in Orchard No. 3.

That portion of the experiment orchard designated as No. 3 was set in the spring of 1912 and comprises a pruning test, a fertilizer test and a variety pruning test. Comparatively little fruit was expected from this orchard during 1914 as it was only the third summer after planting. Dry weather followed the setting of the fruit upon the trees in the spring of 1914, however, and all the fruit that set seemed to remain. Carman produced as high as four baskets per tree in some instances in Orchard No. 3 during 1914. Belle, Champion, Hiley, Connett and several other varieties also produced considerable fruit.

This was also true in other well cultivated orchards of the same age in the State.

It was not expected that there would be much fruit for study from the variety test in Orchard No. 3 until 1915 but enough was secured for preliminary work in 1914. A considerable number of varieties proved to be untrue to name, especially in the case of those not so commonly grown as standard sorts in this State.

PEACH LEAF CURL.

This disease of the peach appears annually with varying severity according to the weather conditions during March and April. During the past two years its attacks have been unusually severe about Vineland. There are two rows of trees across Experiment Orchard No. 1, which have not been sprayed with concentrated lime-sulphur for the control of the San José scale since 1908. They have received the usual summer spraying of self-boiled lime-sulphur that the bulk of the orchard has received, however.

During the spring of 1913, the unsprayed rows were severely attacked by leaf curl and this was the case again in 1914. Fig. 20 illustrates an unsprayed Belle of Georgia and a sprayed tree standing within 15 feet of each other. The marked effect of spraying the trees with concentrated lime-sulphur is quite apparent. Fig. 21 illustrates the same trees after most of the diseased foliage had fallen from the unsprayed tree.

A large proportion of the fruit dropped with the foliage from the latter tree, and the yields of the two compared show that the unsprayed tree produced very little fruit, while the sprayed tree produced several baskets.

The scale has never caused any damage upon the unsprayed trees but the attacks of the leaf curl alone make it necessary to spray the trees annually with lime-sulphur.

The horticulturist has found leaf curl occurring in practically all parts of the state at different times since 1906, with the exception of New Brunswick. Not a single leaf affected with curl has ever been discovered upon a peach tree at the College Farm, even though nursery stock has been purchased from many different states and localities and planted. Some lots of stock have been divided and trees planted at Vineland and High Bridge, as well as at the College Farm. From the fact that trees at Vineland and High Bridge developed curl leaf, it appears certain that the

spores of the disease must have been present at New Brunswick in certain seasons, and that the failure of the disease to develop is likely to be due to some climatic factor.

JUNE DROP OF PEACHES.

In the latter part of May or early in June a proportion of the fruit set commonly falls from the trees. This shedding or falling of fruit has been largely attributed to such factors as lack of pollination and insect and disease attacks. If eggs of the plum curculio hatch and infest a fruit it is certain to fall; severe feeding punctures by the same insect near the stem of the fruit may produce a similar effect.

At times other insects, such as the May beetle and the rose chafer, injure the fruits so that they are destroyed. The occurrence of frost after the fruit has set may cause it to drop. It is a common occurrence, however, to find a considerable amount of fruit falling to the ground without the slightest indication of insect or disease injury. These fruits are generally somewhat smaller in size than the fruits which remain upon the tree. Fig. 29 illustrates some of these smaller peaches ready to fall from the twig.

The cause for these fruits being small and their failure to develop has been attributed to lack of pollination in most instances. This does not appear to be true, however, from observations and studies at the New Jersey Experiment Station.

It has been noted that these small fruits have developed from the smaller fruit buds upon the twigs. Figs. 24, 25 and 26 illustrate the variation in the fruit buds of the peach and their rate of development in early spring.

The work of Huber (pages 64-68) shows that the pollen in these smaller buds which also bloom later than the large buds, is just as viable as that of the larger buds except in instances where the twig is greatly deficient in vigor and it appears certain that as perfect pollination occurs with the smaller buds as with the larger. It is also known that the peach is generally self fertile.

During cold, wet, unfavorable weather at blooming time fruit may fail to set upon the peach from lack of pollination as previously reported by this division,* but this is not believed to be the common cause of the small fruits which fall.

During the season of 1914, the horticulturist in co-operation with Mr. Carl Schwarze, of the department of plant pathology, made observations and tests to determine at what point in the development of the peach tree in early spring the reserve food or starch in the roots and branches of the tree is used up, and the tree obliged to depend upon the work of the leaves to support itself. Frequent starch tests upon roots and twigs proved that the reserve food supply was practically consumed by the time the young fruits were from one-half to five-eighths inch in diameter. Some variation occurred according to the health, vigor of growth and variety of the tree although it was not as marked as might be expected.

*N. J. State Expt. Sta. Rpt. 1913.

FIGURE 31.—Large and small peaches upon the same twig

Another fact commonly observed by peach growers is that rapidly growing young trees frequently lose a considerable proportion of their crop at the time of the June drop. On the other hand, if these trees have been checked a large amount of fruit is retained. Each developing fruit upon the twig must receive a certain amount of food or it fails to maintain itself and necessarily falls from the tree.

The first fruits that set have the advantage of a larger food supply than the late set fruits provided no injury to them occurs, and they indicate this by an increased size at first. If the number of early set fruits is large the late set fruits lack food and remain smaller and finally fall.

The first fruit buds upon a twig to bloom are those which have been the most favorably situated the previous summers and fall to receive plant food If weather conditions are favorable at blooming time they continue to hold this advantage over buds less favorably situated.

If the development and retention of the fruit is a matter of food supply following pollination, we would expect to find considerable variation in the proportion of the drop according to the number of fruits set and the rate of growth of the tree.

The drop is more severe upon very succulent young trees, because much of the reserve food in early spring is used for leaf and twig growth instead of being devoted to the development of the fruit. Trees checked in growth commonly retain a large proportion of the set of fruit, because more of the reserve food is distributed to the fruits.

The percentage of dropped fruit may thus vary greatly according to weather conditions in early spring according to whether it stimulates or checks leaf and twig development. The same facts and laws are as true of such fruits as apples, pears and plums as with peaches, although the proportion of fruit that drops because of lack of pollination alone may be greater with some of the other fruits.

PEACH SHIPMENTS TO BOSTON.

The heavy set of peaches in all districts from Georgia north to New Jersey gave an early indication that proper distribution of the fruit would be an important factor toward the success of the season.

From the fact also that the crop in the New England states was light, Boston appeared to be a promising market for fancy fruit beginning about August 5 to 10, after the bulk of the Georgia shipments was over.

The location of one of the experiment orchards at Vineland has stimulated the development of the peach industry in that vicinity as noted in the annual report of the Station for 1913, and the season of 1914 appeared to be a most appropriate one in which to take up the matter of shipments of peaches in carload lots to distant points. As the season advanced, this promised to be a profitable as well as an instructive line of work.

The heavy crop of fruit within easy shipping distance of New York, combined with the general small size of the fruit, indicated that prices in that market would be low at the height of the season, so the matter of carload shipments to Boston was taken up with the Vineland Peach Growers' Association.

Because of the marked variation between the trees in the fertilizer plots and the fact that the orchard is comprised of a considerable number of varieties ripening over an extended period, the Experiment Station was unable to make full carload shipments of peaches to Boston without stopping all shipments to New York, which was undesirable from the standpoint of losing a practical comparison of the two markets as to prices. *It also offered a chance for real co-operation between the Station and the* peach growers.

Owing to the cold weather of March 21, comparatively few growers had any large quantity of fruit, such as Belle and Elberta, available for shipment to Boston, but from August 22 to 24 three carload shipments were made.

Only one restriction was made as to shipments in these cars. Any grower who cared to enter a number of crates for shipment was allowed to do so provided his fruit was packed in Georgia carriers, and that he notify and arrange with the president of the Peach Growers' Association as to the number of crates he intended to ship.

The horticulturist of the Station assumed the responsibility of the shipments as to the loading, billing, and selling of the fruit.

The Peach Growers' Association arranged for the icing of the cars at point of shipment, the securing of strips for loading, and the details of the number of crates each grower was to contribute to each car.

The first car was shipped Saturday, August 24, over the Central Railroad of New Jersey to New York and over the New York, New Haven and Hartford Railroad to Boston. Refrigerator Car No. 9557 was iced early Saturday *morning in Vineland, and placed at Main Road station about* 10:30 a. m.

Fig. 29 illustrates growers loading crates of peaches in this car.

This car was loaded with 529 crates of fruit, comprised of the varieties Elberta, Belle, Champion and Old Mixon. Six peach growers contributed shipments in addition to the Experiment Station. This car was consigned to a single commission house in Boston, and sold Monday, August 24, 1914.

At the point of shipment, the bunkers of Car 9557 were filled with three tons of ice for which the charge was $5.00 per ton.

The car was shipped under instructions that the bunkers were to be filled up with ice at Jersey City. This required 3,500 pounds of ice at $2.50 per ton.

August 22 was exceptionally hot, and the ice melted very rapidly during the loading of the car. The fruit was also very warm when placed in the car.

Mr. Arthur J. Farley went to Boston previous to the shipment of the fruit in order to note its condition upon arrival.

Upon Monday, August 24, a shipment of one full carload and part of another was made to Boston. Refrigerator Car No. 9499 was loaded with 505 crates, while Refrigerator Car No. 9101 contained 365 crates. Each car was supplied with three tons of ice in Vineland early Monday morning, and placed at Main Road station about 9:30 a. m.

Both cars were re-iced at Jersey City, receiving 2,380 and 2,400 pounds respectively at $2.50 per ton.

Nine growers contributed fruit for this shipment in addition to the Experiment Station, and the varieties of peaches shipped were the same as in Car No. 9557.

Loading of the Cars.

Wooden strips, eight feet long and about three-fourths of an inch square, were used to keep the crates in place in the car to provide for proper circulation of air and the cooling of the fruit. The width of the car's inside measurement was eight feet, four inches. The tiers of crates are stacked up seven crates wide across the car, and as the crates are twelve inches wide, air space to the extent of sixteen inches is available to be distributed evenly between the individual crates and the sides of the car, which actually amounts to an air space of two inches.

The refrigerator car should be of sufficient length to accommodate sixteen rows of crates two feet in length, making 112 crates per tier. But to do this a car will have to be in excess of thirty-three feet in length, inside measurement, because although each row of crates is placed firmly end to end, irregularities in ends, bottoms and covers make it impossible to prevent tiers of crates taking up somewhat more space than the actual length of the crate (24 inches).

For long distance shipments, it is seldom wise to load a refrigerator car more than four tiers high (448 crates) in order to insure proper cooling of the upper tier of fruit. But for such a short shipment as from Vineland to Boston five tiers would probably carry successfully.

Two wooden strips eight feet long and five-eighths to three-fourths of an inch square are required to hold each row of crates in position. This means 32 strips per tier or 112 for four tiers and 160 for five tiers.

For the Boston shipment a good grade of lumber was used for these strips as nothing else was available at short notice, but strips of waste lumber would be satisfactory. The actual expense of the lumber ordered for each car in the Vineland shipments was $3.84 with some material left on hand.

A few pounds of wire nails were required for stripping the crates, making an expense of about 14 to 15 cents per car.

The fruit car had to be loaded hurriedly at the end, because growers did not bring their shipments until late in the afternoon, but where shipments could be delivered regularly throughout the day, the cost of loading would not be great with one or two men stationed at the car or loading point and should not exceed $3.00 to $4.00 per car.

COST OF ICING AND RE-ICING.

The details of the expense of icing and re-icing shipments to Boston were as follows:

August 22-23. Car No. 9557.

3 tons of ice at point of shipment @ $5.00, ...	$15.00
Re-icing, 3,500 pounds, (per ton, $2.50), ...	4.30
	$19.39

Number of crates 529; cost per crate .03

August 24-25. Car No. 9499.

3 tons of ice at point of shipment,	$15.00
Re-icing, 2,380 pounds (per ton, $2.50),	2.98
	$17.98

Number of crates, 505; cost per crate, $.0356.

August 24-25. Car No. 9101.

3 tons of ice at point of shipment,	$15.00
Re-icing, 2,400 pounds (per ton, $2.50),	3.00
	$18.00

Number of crates, 265; cost per crate, about $.05.

Cost Per Crate of Shipments to Boston.

In figuring the cost per crate the items are based on a full carload of 500 crates or more.

The cost for strips is figured on the basis of what was actualy paid at Vineland without deducting for lumber not used. This would at least balance the expense for nails.

The Experiment Station received an average price of $2.25 per crate for most of the fruit sold in Boston. Two crates of Champion sold for $1.75 per crate and ten crates of Elbertas sold for $2.50 per crate. The commission charged was 8 per cent.

Cost Per Crate.

Freight, Icing and Strips,	$0.195
Cartage,	0.03
Commission at 8 per cent.,	0.18
	$0.405

No charge has been made in the above statement for the packing of the crates in the car, but this should not exceed an expense of one cent per crate if proper arrangements are made.

Results of Shipments.

The prices received for the fruit varied considerably, according to quality and variety. Fruit that was scabby, over-ripe or poorly graded did not bring any better prices in Boston than the same fruit would have sold for in New York. In fact such fruit is likely to be in poorer condition on arrival in Boston, even under refrigeration, than when shipped to New York.

The variety Champion proved to be an exceedingly poor shipper. Fine fruit of this variety was well packed in the orchard of one grower, but had commenced to decay upon arrival in Boston, and sold for less than the same fruit would have brought in New York.

Fortunately some crates of this variety from two different orchards were placed in cold storage, and precooled for 24 hours previous to loading in the cars. This fruit arrived in good condition and sold for $0.75 more per crate than the fruit which was not precooled. But even the precooled Champions did not attract buyers and sold for from $0.25 to $0.50 less per crate than Belle or Elberta.

The fruit shipped to Boston was at a disadvantage in comparison to that shipped to New York for a comparison as to prices, because the growers and the general standard of their fruit and pack were unknown to buyers, and the fruit was sold on its general appearance, and the uniformity of the pack in each case. There was no opportunity to work up a special trade for any brand or mark in the limited time devoted to the shipment. Fruit sent to New York by the growers, however, goes to commission men acquainted with the grower, and his fruit and sales should be more readily made.

One or two growers gained little but experience from the Boston shipment and one lost money on a consignment of Champions because they failed to carry well and would have returned a greater profit if sold locally. High grade fruit of Belle or Elberta, uniformly packed and graded, however, sold for higher prices in Boston than in New York.

The freight charge per crate from Vineland to New York is 14 cents in less than carload lots; cartage amounts to 5 or 6 cents per crate and commission is 10 per cent. The extra expense for cartage and commission in New York is sufficient to cover the expense for icing and stripping the cars for Boston.

Growers would be able to reduce the freight rate to New York slightly by shipping in carload lots, but this is not practiced at present.

The Experiment Station contributed a total of 383 crates of peaches to the Boston shipments, and these gave a return of about $256.00 above what the same fruit would have sold for in New York.

The Station shipment bore the entire expense of icing, and re-icing the cars, and the stripping of same and yet deducting the expenses of a man in Boston for several days the experiment returned a considerable profit.

Peach Borer Observations at Vineland.

In conducting extension experiments with peaches at Vineland it became necessary to attack the peach borer in a practical way to prevent injury to trees. No effective remedy except actual cutting out has been established, and this method was resorted to in order to make certain that the trees received good protection.

Experiments with various repellants have been conducted each year by the horticultural division, by Dr. J. B. Smith and recently by Dr. T. J. Headlee. All of the special experiments for borer control are now being conducted by Dr. T. J. Headlee.

As the borers had to be removed from each tree in the experimental orchards, the men were instructed to keep a record of the borers found and the time required to remove them.

The recording of the borer infestation was not undertaken until May, 1913, and all records begin at that time.

In removing the borers the soil was first dug away from the base of the tree about May 10 to 15, and two good men assigned to the work of actually removing the borers.

In "worming" a badly infested tree, the best of men are almost certain to overlook a few borers. By examining the trees a second time a few

days after the first removal of borers any individuals that were overlooked will have made fresh "sawdust," and are then easily located and destroyed. This is the only method that is certain in locating all borers.

The record of borers found in the trees at Vineland is of much interest in showing the character and amount of infestation.

Diagram 1 illustrates the location of the different peach plantings and indicates the character of the surroundings.

Orchard No. 1 was set in 1907; Orchard No. 2 in 1908 and Orchard No. 3 in 1912. The private orchard at the east of No. 1 was set in the fall of 1906, and has never been thoroughly examined for borers. Diagram 2 graphically shows the number of borers found in Orchard No. 1 in May, 1913, with the exception of 18 trees in the northeast corner, records for which are incomplete.

In discussing the number of borers found in Orchards No. 1 and No. 2 the rows are numbered from north to south, and the trees from west to east. The rows and trees indicated by letters are known as plots A, B, C, and were planted in 1908, and are considered separately in each case.

The second row from the east was almost free from borers as will be noted in the diagram 2. This row of trees was treated with Tanglefoot in June, 1912, and it was most effective in keeping out borers. Unfortunately, the material causes injury to the bark of peach trees and had to be discarded.

Another fact that will be noticed in Diagram 2 is the large number of borers in the outside rows on the north, east and south of the orchard.

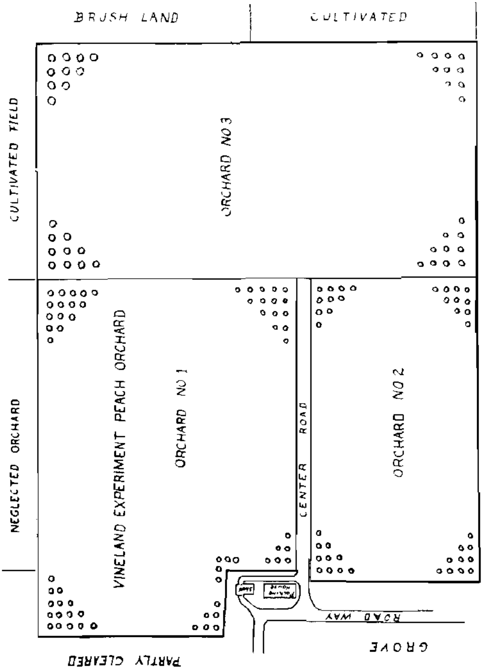
The infestation varies greatly also across the orchard no matter which way we compare the rows.

Row 4 from east to west has 11 trees infested and a total of 22 borers, while Row 6 has 16 trees infested and a total of 55 borers. These rows contain the same varieties of peaches.

The west half of Orchard No. 1 is relatively free from borers compared to the east half.

Table No. 51 states the number of trees by row infested in Orchard No. 1, and the number of borers found. Row 11 has 20 trees infested out of 25 with a total of 36 borers, while Row 7 has only 7 trees infested, but a total of 26 borers. Nine borers were found in Tree 25 of this row, which has a marked effect upon the total.

The total number of trees in Orchard No. 1 is 675 and 326 were found to be infested in 1913, or about 48 per cent. The total number of borers removed from the 326 trees was 693, or an average of a little more than two per tree.



BRUSH LAND
CULTIVATED
CULTIVATED FIELD
ORCHARD NO 3
HEDGE ROW
NEGLECTED ORCHARD
VINELAND EXPERIMENT PEACH ORCHARD
ORCHARD NO 1
CENTER ROAD
ORCHARD NO 2
ROAD WAY
GROVE
PARTLY CLEARED

Diagram I

ORCHARD NO 1 VINELAND, NJ
-1913-

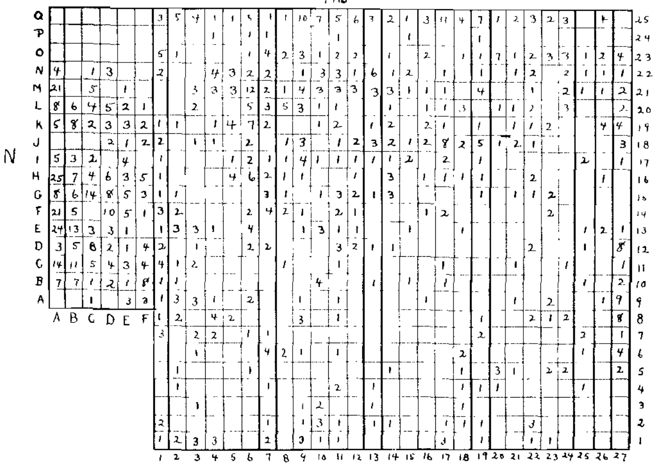


DIAGRAM II.

Table No. 9.—Record of Borers Found in Orchard No. 1. May, 1913 and May, 1914.

ROW.	No. Trees. Infested. 1913	No. Borers Found. 1913	No Trees Infested. 1914	No. Borers Found. 1914
1.	18	35	13	41
2.	13	24	15	51
3.	12	26	16	54
4.	11	22	18	72
5.	7	26	18	51
6.	16	55	23	115
7.	17	42	21	63
8.	11	18	22	94
9.	16	41	19	92
10.	13	31	17	54
11.	20	36	21	45
12.	11	22	21	77
13.	12	23	18	50
14.	13	22	13	29
15.	8	10	11	31
16.	9	14	11	32
17.	13	34	13	38
18.	11	18	15	47
19.	15	29	12	21
20.	6	14	15	36
21.	10	12	15	31
22.	13	23	12	29
23.	9	17	17	31
24.	8	18	12	37
25.	10	12	19	57
26.	8	16	9	22
27.	16	53	7	11
Total.	326	693	423	1311

Each row contains 25 trees.

Table No. 10.—Record of Peach Borers Found in Orchard No. 2. Season 1913 and 1914.

*ROW.	No. Trees Infested 1913	No. Borers Found 1913	No. Trees Infested 1914	No. Borers. Found 1914
1.	76	20	15	70
2.	76	10	12	51
3.	11	15	10	22
4.	8	14	13	46
5.	6	18	11	30
6.	6	8	13	36
7.	11	22	9	27
8.	7	12	12	31
9.	3	4	12	20
10.	4	7	11	25
11.	4	4	10	33
12.	3	4	7	12
13.	4	7	8	18
14.	6	8	14	27
15.	7	11	9	16
16.	4	8	7	14
17.	6	7	9	12
18.	4	4	5	8
19.	5	5	7	8
20.	10	25	12	39
21.	4	10	11	21
22.	4	6	7	16
23.	6	1	12	24
24.	4	7	8	12
25.	5	8	10	16
26.	12	22	8	23
27.	6	12	7	23
28.	4	13	11	86
Total.	306	302	280	766

* Rows begin at North end of orchard.
Each row contains 16 trees.

Diagram No. 3 illustrates the borers found in Orchard No. 1 in May, 1914. A comparison with Diagram 2 shows that more borers were found in the orchard in 1914 than in 1913. A total of 423 trees were infested as against 326 in 1913, an increase of 97. A total of 1,311 borers were found in 1914, or an increase of 618.

The infestation in 1914 was localized in much the same way as in 1913. The east half of the orchard was infested worst, and the outside rows upon the north and east were badly infested as in 1913. Forty-seven borers were removed from Tree H, Row A. It is interesting to note that this tree also held the record in 1913 with a total of 25 borers. In Table No. 9 and in the diagrams it will be noted that the rows that were badly infested in 1913 were proportionately so in 1914. Row 6 had a total of 55 borers in 1913, and 115 in 1914.

It should be noted that Rows 1, 7, 19, 25, and 26 were treated with various materials in June, 1913, to repel the borers. Row 13 was left as a check and all other trees received a spraying of whitewash and lime-sulphur, but these treatments apparently had very little effect upon the borer infestation with possibly the exception of Row 1, which improved its record somewhat in 1914, especially if we disregard Tree 25, which contained 22 borers in 1914 and is apparently an exception to the other trees in the row.

No attempt is made in this report to discuss the experiments with various materials as repellants for borers. It is a matter of considerable extent in itself and will be reported by the entomologist when results warrant it.

The second row from the east, which was so well protected from borers by Tanglefoot in 1913, became badly infested in 1914. The injured bark commenced to peel off, making conditions ideal for the entrance of borers.

Borers Found in Orchard No. 2.

Diagram 4 illustrates the borer infestation in Orchard No. 2 in 1913. This orchard contains 448 trees, 167 of which were infested or about 37 per cent. The total number of borers found was 302 or an average of less than 2 per infested tree. The outside rows upon the west and on the north were infested the most.

Diagram 5 illustrates the borer infestation in the same orchard in 1914. The trunks of all the trees were sprayed with whitewash and lime-sulphur after the borers were removed in May, 1913. The results in Orchard No. 2 in 1914 are similar to those which occurred in Orchard No. 1 in 1914.

The number of infested trees increased from 167 to 282, a gain of 115 trees. The number of borers found increased from 302 in 1913 to 766 in 1914. The detailed records appeared in Table 10.

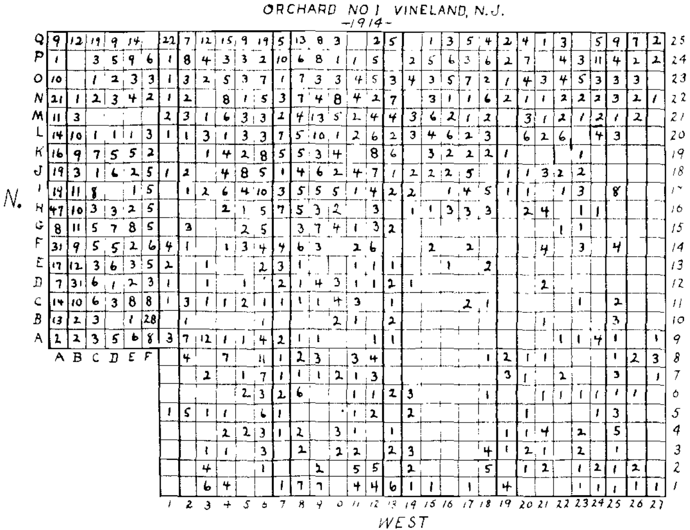


DIAGRAM III.

ORCHARD NO. 2 VINELAND, N.J.

-1913-

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28
16			1	3	7		6										1	1		1	1				2	2		1
15	2	2	3		3		1			1	1		1	2						2		2						
14		1	1		3		2	4									1									3	1	
13				3	3	2	2		1	1						1	1			5					1	1		1
12	6	2	1		1	1	1			1	1			1						1			2					
11	3		1	1		2	1	1			1	2	3		1				1	1							1	
10	2		2				1	1			1	1			3								1				2	
9	2	2	1		1		2							1				1	1	5			2	1		1		
8	2								2	4					1						1	1				1		
7	3		1					1							1				1	3						1		
6			2	2		1		1						1		2	1			3	2			1		1		
5				1				2							2				1	3						1		
4			1				1											1		1		2	1	1	1	4		
3				1		1						1	1													1	5	9
2		1		2			1							2	1	2	1						1		2	2	1	2
1		2	1	1		1	4	2	1				2	1	2	3	2	1	1		6	1	4	4	2	4	2	

W

DIAGRAM IV.

ORCHARD NO. 2 VINELAND, N.J.

—1914—

3	3	1	1	5	2	1	3	1	3	1		3	2	1	2	1	3	2	5	3	4	5	1		3	1	5	16
3		1	4	3	4	4		3	1	4	1	1	1							1				1				15
3	3		10	1	3	5	5	2	1	5		4			1	1			2		2	2	1				1	14
9			6	3	5		1			9	1	1	3			2		1	2			1		1				13
3	3	2	8	4	3		3		2	3		1	4	2		1			6	3	2	2			2		2	12
4	2		2		3	2	2	2	2		1		2						5	1		1	2	1	3			11
6	4	3	2	5		2	3	1		2	2				1	1	2			1		1					2	10
6	6	2		2			7	1	3		3	3	1			1	1		3					3				9
5		4			5		2	1	2		3		1	1				1	3		1	1	1		1	2	2	8
2	6	2	2		1	1				2			4	2	1	1			1	2		2		2		5		7
2	7		4	1		1	1	1	3				1	2		1		1	4	3		3		1		1	15	6
8					2		1		2	1			1				1	1	5				2	1	2		2	5
3	9	2	1		3			1					1	4	2				1	2	4	1	2	1	5		2	4
3	3	3	2	2	1			1					1	1				1		1	2		1	3		10	24	3
10	2	2	2	2	3	3	1	4	3	5		4	3	2	6	3	1			3		4	2	2	4	2	22	2
	3		2	2	1	8	2	2	3	1	1	1	2	1	1			3	2	1	1	1			3	2	9	1
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	21	21	22	23	24	25	26	27	28	

WEST

DIAGRAM V.

ORCHARD NO.3 VINELAND, N.J.

-1913-

2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	
				1				3		1	2	1	2		1															16
			1								1															1			4	15
	2		1																		1	1		1		2				14
																										1	1		1	13
3										1					1	1			1										3	12
														1	1		1	1			1				1					11
		2						1									4						1					3	1	10
					1														1										1	9
																			1										2	8
1											1				1							1			1					7
								1	1	1				2									2			1		2	1	6
		1	1	3			1					1		1	1	1	1		1				3		3		2	1		5
1			1						2		1	2											1	1	1	1	1	2		4
2		1	3				1		2		1	1	1						3	1		1	1	2	2		1	1	1	3
			1	1					1						1			1							2	2	1		1	2
	1		3						2							1	1								1	1		2		1

N

DIAGRAM VI.

ORCHARD NO.3 VINELAND, N.J

-1914-

				1		3	4		1	1	5	8		1															16
1				3				1		1	1				1		1										2	1	15
1							1	2															1		10	2			14
	1						1			1			1	2							1				1			1	13
	3	4	5	1		1	1						1				5										5	6	12
																									2		2	2	11
2		1														1					1			1	1	1			10
1	1	1																	1			2		1	4				9
1				1						1	2			1							2			2			2		8
											1	3																	7
	1					3		2	2		2	1				1	1		3	2		1	1	3					6
	3	3		2					2		1	1	1		1		1	2				3	1	5	1	2		2	5
		1	1		1					1									2		2		1						4
2	2	3	2		2				1	1		3		1			3	13	3	1	1	3	4	1	2	1			3
1			1					1			1			2			3	1	1						1				2
4		2				1									1	1			2			3					3		1
3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	

N.

DIAGRAM VII.

Table No. 11.—Record of Peach Borer Infestation by Rows in Orchard No. 3. Borers Removed in May 1913 and May, 1914.

* No. ROWS.	No. Trees Infested 1913	No. Borers Found, 1913	No. Trees Infested 1914	No. Borers Found 1914
1.	9	14	9	28
2.	9	11	10	13
3.	17	25	21	54
4.	11	14	8	12
5.	14	21	18	35
6.	8	11	14	29
7.	5	5	3	5
8.	1	3	10	18
9.	3	3	7	11
10.	6	12	8	10
11.	6	6	4	7
12.	6	10	11	34
13.	3	3	8	9
14.	6	8	6	17
15.	5	8	9	12
16.	7	11	9	25
Total.	116	165	155	319

* Beginning at north side.

*In Orchard No. 2 the worst infestation of borers occurred in the north-*east and the southwest corners both in 1913 and in 1914.

Borers Found in Orchard No. 3.

Orchard No. 3 consists of 496 trees set in 1912. The removal of borers in May, 1913, was then the first worming which these trees received. An examination of Diagram 6 shows that the infestation was light. An actual count shows that 116 trees were infested or about 23 per cent. A total of 165 borers were found or an average of less than 2 per tree. The area infested the most is the southwest corner. One would expect that the northwest corner might be the one most attacked, as it adjoins the southwest corner of Orchard No. 2, where infestation is always considerable, but such was not the case in 1913.

Diagram 7 indicates the results of borer removal in Orchard No. 3 in 1914. The number of trees infested increased from 116 in 1913 to 155 in 1914, and the number of borers from 165 to 319. The southwest corner again showed considerable infestation as in 1913, and the northwest corner has now become considerably infested also as would be expected since it adjoins a similarly affected area in Orchard No. 2.

Time Required for the Removal of Borers.

Since both the number of infested trees and the total number of borers was determined in each orchard, the time reqnired to examine the trees and remove the borers is of much interest and value.

Mr. William Schieferstein and Mr. Warren W. Oley were the young men who did this work. They undoubtedly worked more thoroughly and rapidly than would be the case with men hired for snch a purpose.

The credit for these complete records is due and gladly given to the above mentioned men.

In 1913 it required the time of two men for eight hours to examine 448 trees in Orchard No. 2 of which 167 were infested with borers. The rate of examination of all trees was, therefore, 28 per hour per man. The rate of the removal of borers from the infested trees cannot be definitely determined as no record was kept of the actual time spent in examining trees not infested. Such a practice would require more time than the results would warrant. The work can also be expressed in this way. Two men were able to examine trees at the rate of 56 trees per hour, and remove an average of 37 borers per hour where the percentage of trees infested was about 37 per cent. or a little more than one-third, and where the number of borers per infested tree averaged less than two.

In 1914 it required the time of two men for about eleven and one-half hours to examine the trees, and remove the borers from this orchard. The rate of examination of all trees was about 20 trees per hour per man. Two men were able to remove an average of 65 borers per hour where the percentage of trees infested was nearly 63 per cent. and where the average number of borers per infested tree was between two and three.

In Orchard No. 1 in 1914 two men were able to examine trees at the rate of 34 per hour and to remove an average of 66 borers per hour where the percentage of trees infested was about 62 per cent. and the average number of borers per infested tree was practically three.

Plots A, B, and C, or Rows A to F inclusive contain 102 trees, about 91 per cent. of which were badly infested with borers in 1914. Two men were able to examine about 20 trees per hour and to remove about 140 borers per hour where the average number of borers per infested tree was between 7 and 8 and where one tree contained 47 borers.

Orchard No. 3 was not as badly infested, and in 1914 two men were able to examine 56 trees per hour and to remove an average of 36 borers per hour where the percentage of trees infested was about 32 per cent. and the average number of borers per infested tree was about two.

The work in all the orchards was done by the same two men, and it is interesting to note the rate of removal of borers on that account.

Effect of Pruning Upon Borer Removal.

The character of the pruning of the trees has a direct bearing upon the rate of borer removal. If low branches are allowed to remain upon the trunk near the ground, they greatly hinder the removal and the replacing of the soil about the trunk besides interfering with the men who may actually remove the borers.

No estimate has been made of the time required to remove and put back the soil about the trunks of the trees in this discussion as further data is desirable.

Summary of Observations.

A rather complete study for two years in orchards containing over 60 varieties of peaches does not indicate that one variety is more immune from the attacks of the peach borer than another.

Certain sections of orchards become infested more quickly and more completely than others.

Outside rows are commonly more severely infested than interior rows, even regardless of the surrounding conditions.

Trees once infested or injured are apparently very susceptible to continued attack. Rows of trees badly infested one year are, therefore, likely to be proportionately affected in succeeding years.

A row lightly infested may occur alongside one quite badly infested where the varieties and cultural conditions are the same.

The results of experiments with borer repellant considered on the basis of the actual number of borers found after treatment are not complete unless a previous record of infestation has been made.

Trees should be examined twice for borers. The examinations to be made a few days apart so that any borers that are overlooked the first time can be discovered at the second examination by the fresh "sawdust."

Blooming Dates of Tree Fruits at College Farm.

The blooming dates of tree fruits not only indicate differences due to variety but also note the general character of the season in early spring. A comparison of the blooming dates of tree fruits at the College Farm for the years 1912, 1913, and 1914 shows that the blooming season of 1913 was very early, while that of 1914 was about three to five days later than 1912. The difference being greatest with the standard pears, peaches and apples and least with the dwarf apples.

Table No. 12.

Blooming Dates of Standard Apples.

VARIETY.	*Season 1912.*			*Season 1913.*			*Season 1914.*	
	First.	Full.	Last.	First.	Full.	Last.	First.	Full.
Gravenstein	5/1	5/8	5/13	4/18	4/27	5/6	5/4	5/7
Oldenburg	5/1	5/10	5/13	4/17	4/26	5/4	5/3	5/7
Jonathan	5/6	5/12	5/19	4/22	4/30	....	5/7	5/12
King	5/2	5/9	5/14	4/23	4/30	5/6	5/4	5/10
Baldwin	5/4	5/10	5/14	4/24	5/1	....	5/7	5/11
Smith Cider	5/2	5/10	5/14	4/22	5/1	....	5/7	5/10
Williams	5/8	5/13	5/20	4/26	5/2	....	5/9	5/14
Yellow Transparent	5/1	5/8	5/12	4/21	4/30	....	5/7	5/11
Monmouth Pippiu	5/4	5/11	5/15	4/23	4/30	....	5/8	5/9
Ben Davis	5/4	5/12	5/15	4/24	5/1	....	5/7	5/10
Stayman Winesap*	5/5	5/12	5/19	4/23	5/1	....	5/6	5/8
Champion*	5/7	5/13	5/20	4/24	5/2	....	5/5	5/8
Rome*	5/8	5/13	5/20	4/26	5/3	....	5/7	5/12
Delicious*	....	....	....	....	....	....	5/7	6/10
Banana*	....	....	....	....	....	....	5/9	5/11
King David*	....	....	....	....	....	....	5/6	5/10

*Young trees.

Table No. 13.

Blooming Dates of Dwarf Apples.

VARIETY.	Season 1912.			Season 1913.			Season 1914.	
	First.	Full.	Last.	First.	Full.	Last.	First.	Full.
Oldenburg	5/2	5/8	5/13	4/19	4/26	5/3	5/4	5/8
Bismark	5/5	5/12	5/16	4/19	4/29	....	5/7	5/12
Baldwin	5/8	5/12	5/15	4/26	5/1	....	....	....
Gravenstein	5/3	5/12	5/16	4/20	4/27	5/3	5/4	5/7
Jonathan	5/8	5/12	5/16	4/25	4/29	....	5/7	5/12
Fall Pippin	....	....	....	4/24	5/1	....	....	....
Alexander	5/7	5/13	5/17	4/23	5/1	....	....	....
Chenango	5/7	5/13	5/17	4/24	4/30	5/5	....	....
McIntosh	5/6	5/11	5/15	4/21	4/27	5/3	5/6	5/9
Wealthy	5/8	5/13	5/17	4/22	5/3	....	5/7	5/10
Red Astrachan	....	....	....	4/19	4/26	4/30	5/4	5/6
R. I. Greening	5/10	5/14	5/22	4/23	5/1	....	....	....
Banana	5/8	5/12	5/18	4/23	5/3	....	5/7	5/10
Delicious	....	....	....	4/25	4/29	5/2	5/8	5 11
Newtown	....	....	....	....	....	....	5/8	5/12
Roxbury	....	....	....	....	....	....	5/10	5/13
Opalescent	....	....	....	....	....	....	5/11	5/14
Esopus	....	....	....	....	....	....	5/9	6/13
Twenty Ounce	....	....	....	....	....	....	5/7	5/12

Table No. 14.

Blooming Dates of Pears.

VARIETY.	Season 1912.			Season 1913.			Season 1914.	
Young Trees—	First.	Full	Last.	First.	Full.	Last.	First.	Full.
Dewey†	4/28	5/3	5/8	4/11	4/16	....	5/3	5/7
Dewey‡	....	....	....	4/12	4/18	....	5/3	5/7
LeConte †	4/30	5/5	5/8	4/12	4/18	....	....	....
LeConte‡	....	....	....	4/11	4/17	....	....	....
Louise Bonne	4/30	5/5	5/7	....	....	....	5/3	5/6
Duchess*	4/30	5/5	5/8	4/17	4/22	....	5/3	5/6
Bartlett†	4/30	5/4	5/9	4/17	....	5/1	5/4	5/7
Bartlett‡	5/2	5/8	5/12	4/10	....	....	5/4	5/7
Kieffer†	4/29	5/4	5/9	4/16	4/21	....	5/2	5/7
Clarkesville	4/30	5/4	5/9	4/18	4/27	5/2	5/3	5/5
Worden	....	....	....	....	....	....	5/4	5/6
Old Trees—								
Seckel	5/2	5/7	5/9	4/17	4/22		5/4	5/6
Lawrence	5/1	5/6	5/8	4/9	4/18	4/25	5/1	5/6
Dorset	5/1	5/6	5/9	4/18	4/24	....	5/3	5/6
Bartlett	5/1	5/6	5/9	4/12	4/21	....	5/3	5/6
Kieffer	....	....	....	4/10	4/17	4/24	4/29	5/5
Sheldon	....	....	....	4/17	4/22	....	5/4	5/6
Idaho	....	....	....	4/18	4/22	....	5/4	5/6

*†Oriental stock. ‡French Stock. *Dwarf.*

Table No. 15.

Blooming Dates of Peaches and Nectarines.

VARIETY.	Season 1912.			Season 1913.			Season 1914.	
Peaches—	First.	Full.	Last.	First.	Full.	Last.	First.	Full.
Triumph	4/24	5/2	5/6	4/6	4/14	4/24	4/29	5/3
Maule's Early	4/23	4/30	5/4	4/5	4/13	4/21	4/23	5/3
Dewey	4/23	5/2	5/7	4/7	4/15	4/23	5/2	5/6
Mayflower	4/24	5/1	5/6	4/5	4/12	4/22	4/24	5/3
Greensboro*	4/25	5/3	5/7	4/8	4/16	4/24	4/28	5/2
Slappy	4/27	5/2	5/5	4/7	4/15	4/22	4/23	5/2
Frances	4/26	5/2	5/5	4/7	4/13	4/21	4/26	5/3
Belle	....	....	....	4/5	4/12	4/22	4/27	5/3
Carman	....	....	....	....	....	....	4/27	5/2
Nectarines—								
Downtown	4/25	5/2	5/6	4/6	4/13	4/20	4/28	5/3
Pitmaston Orange	4/25	5/2	5/6	4/7	4/14	4/22	4/29	5/2
Elruge	4/26	5/1	5/6	4/7	4/12	4/19	4/28	5/2

*Dwarf

During the season of 1914 the blooming dates were recorded of a considerable number of ornamental trees and shrubs and these are listed in Table 16.

Table No. 16.

Blooming Dates of Trees and Ornamentals, College Farm, 1914.

	First Bloom	Full Bloom
Acer platanoides	4/26	4/29
Acer Pennsylvanicum	5/6	5/9
Acer rubrum	4/12	4/18
Acer saccharinum	4/20	4/28
Aesculus Hippocastanum	.	5/23
Aesculus carnea	5/12	5/21
Berberis Thunbergii	5/6	5/15
Berberis vulgaris	5/16	5/21
Celastrus scandens	6/7	6/10
Caltis occidentalis	5/6	5/8
Cercis Canadensis	5/6	5/8
Cornus florida var. rubra	5/8	5/12
Cornus paniculata	6/5	6/9
Cornus sanguinea	5/20	5/27
Corylus Americana	3/28	3/30
Daphne Mezereum	3/29	3/31
Deutzia scabra	5/20	....
Diervilla Japonica	5/20	5/28
Euonymus alatus	4/13	....
Forsythia suspensa	4/22	4/26
Forsythia viridissima	4/6	4/22
Juglans cinerea	5/16	5/20
Kalmia latifolia	5/29	6/6
Kerria Japonica	..	5/20
Koelreuteria paniculata	7/2	7/7
Lindera benzoin	4/1	4/18
Magnolia glauca	6/9	6/12
Morus nigra	5/10	5/14
Ostrya Virginica	4/2	4/28
Populus balsamifera	4/8	4/18
Prunus Avium	4/30	5/4
Prunus Pennsylvanica	5/3	5/7
Prunus serotina	5/20	5/25
Quercus imbrecaria	5/10	5/14
Quercus pedunculata	5/9	5/12
Quercus Prinus	5/17	5/20
Rhododendron maximum	5/21	5/28
Rhus Canadensis	5/12	5/15
Rosa rugosa	5/19	5/24
Rosa setigera	7/3	....
Salix alba	5/4	5/9
Salix Babylonica	5/6	5/14
Sorbus Americana	....	5/23
Spirea Van Houtii	5/18	5/23
Symphoricarpus racemosus	6/1	6/7
Syringa vulgaris	5/12	5/16
Ulmus Americana	3/31	4/10
Ulmus campestris	4/11	4/20
Vaccinium corymbosum	5/11	5/15
Viburnum dentatum	5/29	6/11
Viburnum Opulus	5/20	5/28
Wistaria Chinensis	....	5/19

WEATHER REPORT.

The season of 1914 was one of the most variable that has been experienced in many years.

Warm weather was late in appearing and the blooming period of fruits was delayed. The rainfall was only slightly below normal for the months of April, May and June, but beginning with August the state experienced the most severe and prolonged drought in years. During September the

only precipitation occurred on the 26th, and then it amounted to only 0.41 inches. October was very dry, also, the total rainfall being 2.50 inches below normal. It was very fortunate for farmers and fruit growers that the severe drought was delayed until August, after many crops had reached their development.

Certain varieties of apples such as Baldwin were noticeably affected by the drought. Baldwin "spot" and watercore were unusually prevalent.

The last spring frost at New Brunswick occurred on May 1st, with a minimum of 32°. This was not severe enough to cause any injury to plants at the College Farm. The first killing frost in the fall occurred upon October 28th.

The highest maximum (96°) occurred on September 22nd. This is another unusual feature. The very dry weather with the high temperature in September made the culture of roses and chrysanthemums in the greenhouse more difficult than usual. The lowest temperature occurred on January 13th with a minimum of -4°.

The winter and spring seasons were most favorable ones to fruit trees, and a very heavy set of fruit resulted in general. A minimum of -6° at Vineland on the 21st of March was a most unusual occurrence and caused considerable damage. The weather observations at the College Farm are now being made by Mr. A. J. Farley and Mr. William Schieferstein.

Daily and Monthly Precipitation in Inches at College Farm for the Year Ending October 31st, 1914.

	November 1913.	December 1913.	January 1914.	February 1914.	March 1914.	April 1914.	May 1914.	June 1914.	July 1914.	August 1914.	September 1914.	October 1914.
1					1.20	0.41			0.19			
2			.20		0.48				1.45			
3			.40		T.					0.04		
4	T.						.55	0.52		0.15		
5			.48	T		T.	1.69	0.08	0.02			
6	T.			0.25	0.40		.26		0.05			
7		0.49		0.23			.04	0.26	0.70			
8	0.16					0.32	.02					
9	.60						T.					
10	.14	.10		.04								
11				T.			0.32			0.26		
12			T.			0.02	0.26	0.12	0.09			
13									0.15			
14				0.89					0.34			
15			T.			0.38		0.42	0.12			.01
16	.25		.18	0.27		0.16			0.08			1.38
17	.56		.01						0.46	T.		0.22
18				T.	0.38							
19				0.46				0.46				T.
20	.05		.69		0.04	0.22				0.11		
21										0.58		
22	1	.15			0.12	0.06		.10				
23		1.98		0.12					0.10			
24	.02		1.01	0.26				.32				
25		.48	.33			0.65			0.08		0.41	
26	T.	0.01			0.04	0.78						
27	.50						0.98	T.	0.96			
28	.12				0.57			0.04	0.34			
29						T.			0.20	0.36		
30					0.08		0.03		T.	0.04		T.
31			1.26							0.34		
Total	2.20	2.21	4.85	2.52	3.31	3.00	3.65	2.33	5.33	1.87	3.41	1.61
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

Report of the Animal Husbandman.

The area devoted to swine investigation was materially increased during the past year, there now being fifteen acres utilized by this department. It was proposed to establish a unit area such as would use to advantage the services of one man as swine herdsman, and at the same time develop intensively the tillable land available for forage crops. To this end the following lines of work were undertaken and planned:

1. The determination of the comparative cost and value of selected forage crops suitable for swine feeding.
2. The rapidity of growth and comparative vigor of pigs grown by foraging as against those developed in restricted areas or pens.
3. The possibility of developing an animal naturally resistant to disease by establisbing hardiness and perpetuating strong constitutional vigor.
4. A study of commercial sources of food stuffs, chiefly waste products, adapted for feeding swine.
5. The use of mineral mixtures as a means of preventing rooting and destruction of plants in the pastured field.
6. The usefulness of alfalfa hay as a source of protein for brood sows, together with a study of conditions resulting from the practice of wintering brood sows in grouped colony houses partially covered with litter as a protection against cold and exposure.
7. A continuation of the experiment to determine the feeding value of garbage tankage or "stick" in fattening hogs—chiefly to devise means of making this material palatable and practical as a source of food.
8. Hogging down corn, is this practice feasible for the Eastern farmer?
9. Average costs per pound of gain and of maintenance of animals in the herd for the year.
10. Possibilities of pork production for the New Jersey farmer with suggestions for a revival of this once famous Jersey industry. Statement of existing conditions and practices.
11. Deductions from breeding practices in the Station herd with observations resulting from in-breeding, cross breeding and the mating of animals very closely related.
12. Breeding records of matrons in the herd representing the various breeds.

Forage Crops For Swine.

From observations made at this Station during the past two years it would seem that the following statement is conservative and substantiated by fact; namely, that the use of forage crops for swine is quite as essential for economical pork production as ensilage is necessary for economical milk production, and that alfalfa hay is as valuable, pound for pound, for the sow and growing pigs as it is for the cow and the growing calf; furthermore, forage crops may be more readily and more economically harvested by pigs than by man, and that this practice is a definite means of conserving as well as adding soil fertility.

Three crops stand out pre-eminently as a source of such feed-alfalfa, dwarf Essex rape and soy beans—the former by itself, the latter two in combination. With cost and convenience considered it seems clear that rape and soy beans are a surer and safer crop to rely on for Eastern farm conditions than alfalfa; for they can be grown on a greater variety of soils and field conditions; the cost of seeding is much less, while the foraging season extends over a greater period of time. Furthermore, a most convenient and short rotation may be followed utilizing rape and soy beans, rye and vetch and corn with rape and rye,—all being very useful for swine at a time when they are most needed. The rye makes both early and late forage, while there is nothing more hardy or resistant to climatic variations than the dwarf Essex rape.

Field No. 10 consisting of four acres was seeded with rye on November 27th, 1913. The field is naturally low and poorly drained, and owing to the unfavorable growing conditions during the late fall the rye did not make much growth. However the plants took root early in the spring and on March 31st, twenty-two brood sows averaging three-hundred pounds were turned into the field. They were fed in addition to the rye forage two pounds of ear corn per head daily and gained slightly more than one-half pound per day. This number of hogs were unable to keep the rye cropped down and on May 19th the field was plowed preparatory to seeding with rape, soy beans and sweet clover. The following mixture was seeded per acre: 1 bu. Ito San soy beans, 6 lbs. dwarf Essex rape, 10 lbs. sweet clover.

The soy beans were drilled by means of a grain drill, and the rape and clover mixed and put in with an alfalfa seeder or press drill, in the opposite direction to insure a more perfect stand. The fertilizer mixture used was as follows: 200 lbs. acid phosphate, 50 lbs. muriate of potash, 50 lbs. nitrate of soda per acre.

The cost of preparation and seeding was as here noted: plowing, preparing and seeding the ground, man and team, 9 hours at 50c per hour—per acre, $4.50; 1 bu. soy beans, $2.00; 6 lbs. rape, at 6c per lb., 36c; 10 lbs. sweet clover, at 16c per lb., $1.60; 300 lbs. fertilizer, $3.25; cost per acre, $11.71. Total charges for labor, seed and fertilizer (4 acres) $46.84.

The season was especially favorable for the growing of soy beans and rape, and the plants made a most wonderful showing. On July 15th by actual measurement, a number of plants averaged 18 inches in height. On this date fifteen brood sows, weighing 4,126 lbs. were turned in the field. They were not given any grain whatsoever until September 18th. The sows with four exceptions, were bred for fall litters, and the pigs that were later farrowed exhibited unusual vigor and vitality. It was plainly evident that this number of brood sows would be unable to utilize to advantage the forage supplied by this four acre area, and on August 3rd seventeen spring

pigs, weighing 2,405 pounds were turned into this lot. Even this additional number of animals failed to make an impression on the forage available, and on August 17th nineteen more animals, weighing 1,721 pounds were added, making a total of fifty-one head weighing 8,460 pounds live weight, or approximately one ton of live weight per acre. This number of animals were pastured until October 31st when they were removed and the area plowed preparatory to seeding with rye for early forage. The brood sows were given no additional feed whatsoever until September 18th. when 25 pounds of corn per day was fed to the fifteen head. The spring pigs were given an allowance of three-quarters of a pound of corn for each hundred pounds live weight per day.

Deducting the cost of the corn consumed, the four acre area of rape and soy beans was responsible for a total gain in live weight of 1,854 pounds, which at ten cents per pound would be worth $185.40, or at the rate of $46.35 per acre. It must be remembered, however, that it was not intended that the brood sows should gain in weight materially, for under average condition a brood sow that is mated while in a relatively thin but vigorous condition does very well if she gains one-half pound per day from the date of mating until the pigs are farrowed. In this particular case the brood sows were in good condition when turned into the field, and maintained their weight throughout the season. Practically all of the gain was made by thirty spring pigs, and the figures might properly be interpreted as showing a gain of 1,854 pounds by the thirty pigs in sixty days, or slightly more than one pound of net gain per day.

In making this calculation it was assumed that 400 lbs. of corn was responsible for 100 lbs. of gain, live weight, and the feeding value of the corn consumed was determined in this way, and deducted from the total gains maintained and pastured in this area.

This is not all. The animals were always clean, healthy and vigorous. The voidings were evenly distributed, they required practically no care or labor, and were cool, comfortable and happy. The pigs farrowed were strong and active; the dams responded to feed readily when the change was made, for their digestive system was in the best of tone, due to the forage crop rations, they being cooling and invigorating. This goes to show what a forage crop mixture of this sort means to the farmer interested in this phase of animal husbandry.

Obervations disclosed the interesting fact that the pigs preferred the bean forage and that the rape was next in palatability. The clover was smothered during the early part of the season, but proved very hardy and attractive later in the fall season. The field was planted and seeded with rye on December 1st and will be planted with corn after the rye has supplied green forage during early spring.

Hogging Down Corn.

Field No. 8 containing two acres was likewise seeded with rye on November 27th. The field furnished green forage for the breeding

animals during early spring. On May 29th the rye was cut with a mowing machine and the crop stacked to be used during the winter months in covering the colony houses. The two acre field yielded two tons per acre of rye straw. On June 21st the field was plowed and planted with Silver King corn and Ito San soy beans, and just previous to the last cultivation on August 14th, a mixture made up of six pounds of dwarf Essex rape and sixty pounds of rye per acre was broadcasted between the rows. This variety of corn being unusually early in its maturing qualities was considered entirely ripe on October 19th, on which date thirty pigs were turned into the field. The soy beans did not germinate very satisfactorily, and they were dwarfed due to the continued dry weather. The same is true of the rye and rape, as the continued dry weather checked the growth, and the plants were only about four inches high when the pigs were turned into the field to "hog down" the crop.

The following tahle gives in detail the returns from this field during the season, dating from June 2nd to October 31st.

No. of animals used.	Date turned into field.	Date removed.	No. of hogs No. of days in field.	Initial weight.	Final weight.	Total gain.
1	Oct. 19	Oct. 31	1 (12)	252 lbs.	296 lbs.	
29	Oct. 3			3630 lbs.		
29		Nov. 23	29 (23)		4362 lbs.	
			Totals.	3882 lbs.	4658 lbs	776 lbs.
Gain per pig per day						1.16 lbs.
Total lbs. pork produced per acre						345 lbs.

Summarized it will be noted that 776 pounds of pork was produced from this area with twenty-nine pigs averaging 127 pounds each in twenty-three days, or a total income of $34.50 per acre with pork selling at ten cents per pound live weight. This does not take into consideration the early forage from the rye nor the rye straw itself.

Owing to the lateness of the date of planting and the unfavorable season conditions, it is estimated that had this area of two acres of corn been shocked and husked the yield would scarcely have amounted to thirty-five hushels per acre. Corn on this date was selling at seventy cents per bushel of eighty-five pounds. The pigs harvested the crop without any lahor cost and marketed same at the rate of One Dollar ($1.00) per bushel. A clear profit of 30 per cent. in addition to labor saved and the manure voided; which income goes to show that hogging down corn is an economical means of disposing of a restricted area of the eastern corn crop.

Field No. 9 containing three acres was seeded with rye and vetch on November 27th, 1913. The brood sows farrowing early litters were pastured on this field during the early spring and up until May 26th, when the field was plowed and planted with corn and soy beans. A total of twenty-five animals averaging 190 lbs. grazed on this rye for sixty days. A mixture of Leaming corn and soy beans was planted on May 26th, in rows three feet six inches apart and the field was gone over with a cultivator five times. On August 4th a

mixture of six pounds rape and sixteen pounds of soy beans per acre was drilled between the rows by means of a special disc seed drill. The weather conditions were unfavorable for prompt germination of this cover crop seed, and consequently the plants were not very large when the pigs were turned in to "hog down" the crop on September 15th. On this date it was calculated that 80 per cent. of the corn was in the milk stage, and only 20 per cent. fully dented. On October 1st it was estimated that the crop had all matured and was fully dented. The soy beans that were planted with the corn were ripe and fully podded on this date, but it is doubtful if the beans should be considered in the calculations inasmuch as the stand was very poor, and the plants most irregular in size and degree of ripeness. The rape and soy beans were seeded just previous to the last cultivation of the corn and averaged eight inches in height when the animals were turned into the field; but unfortunately the stand was poor and plants irregular in growth and appearance. At the outset the pigs did not bother the corn, but were content to nibble away at the soy beans and rape. On September 26th, however, two old sows were turned in and started breaking down the stalks, and the smaller pigs soon joined in this method of feeding. The pigs utilized, in this feeding experiment, averaged about eighty pounds, and the following records of weight and gains of the fifty animals gives in detail the total gains as well as the rate of gain per day.

No. of animals.	Date first turned in.	Date removed.	No days in field.	Initial weight. Lbs.	Final weight. Lbs.	Total Gain. Lbs.
25	Sept. 15	....	....	1750	....	....
24	Sept. 18	....	....	1495	....	....
1	Oct. 3	....	....	231	....	....
4	Sept. 15	Oct. 6	4 (21)	....	220	....
10	Sept. 18	Oct. 13	10 (25)	....	528	....
2	Sept. 18	Oct. 16	2 (28)	....	70	....
(1	Oct. 3	Oct. 29	1 (26)	....	489	....
4 (3	Sept. 15	....	3 (25)	....	....	....
30 (18	Sept. 15	Oct. 31	18 (46)	....	3630	....
(12	Sept. 18	....	12 (43)	....	....	....
50–50			50 (1835)	3476 lbs.	4937 lbs.	1461 lbs

Summarized, it will be noted that fifty animals averaging eighty pounds each foraged on the three and one-half acre field for 36 days; that they made a total gain of 1,461 lbs.; or an average of .79 lbs. per pig per day. At 10c per lb. the total value of the pork obtained from this area was $146.10 at the rate of $41.74 per acre.

It is generally conceded that pigs weighing 125 lbs. are best suited for "hogging down" corn, and while the young pigs in this case averaging eighty (80) pounds made satisfactory gains and yielded a clear profit, it is very probable that older animals would have gained more rapidly and, therefore, more economically. This area was plowed and seeded with rye on November 20th, and will furnish early forage for the breeding stock.

Rape and Sweet Clover.

An interesting experience with rape and sweet clover is here noted. The use of colony houses for wintering brood sows made it necessary

to use a small area of each of the alfalfa plots for locating the houses. Early in the spring these end lots were plowed and seeded with rape and sweet clover. To our astonishment the pigs preferred this mixture to alfalfa, and it was necessary to construct a temporary fence to keep them from pasturing the rape and clover plants too closely. A relatively immense amount of forage was supplied by these restricted areas, and when it was necessary on October 15th, to shut the pigs out of the alfalfa runs, there still remained an abundance of feed in the areas where this mixture had been seeded. Again, the alley ways leading to the three acre fields were seeded with rape and sweet clover, at the rate of 6 lbs. of rape and 10 lbs. of sweet clover per acre. The pigs pastured and tramped these areas almost continually, yet in spite of this severe usage the plants survived and always attracted the foraging pigs. It would seem that a mixture of rape and sweet clover, or of rape and soy beans and sweet clover is clearly the mosr promising forage crop combination for swine.

Alfalfa Forage.

The five half acre plots of alfalfa were utilized again this year for pasturing brood sows and their litters. It was decided to plow and reseed three of the plots since they were pastured very severely last year and evidenced winter injury. It will be remembered that in 1913 three of the plots were pastured well into November to determine, if possible, the effect of late pasturing. In cases where the pigs were removed on October 15th, there were no evidence of injury or destruction of plants from any cause, but where the lots were used until November 15th, for foraging runs, the plants failed to respond to fertilization in the spring, and did not furnish much feed the following year.

Two of the plots, No. 5 and No. 7, were pastured along and not cut over with the mower in 1913 to determine if such clipping was beneficial or necessary. It is very evident that such clipping is essential, for both lots thus neglected failed to pasture as many hogs in 1914 as those where two cuttings had been made, and the hay taken off and used for winter feeding.

The number of sows and their litters that can be pastured with safety per acre throughout the season was found to be five this year, providing they are given a liberal grain ration during the time when they are nursing the pigs. The most rapid and economical gains resulted in case of two Duroc sows that were fed ear corn with 10 per cent. tankage while grazing on alfalfa forage. The pigs responded to this ration and made more than their 1 lb. per day throughout the season. On a basis of net gain per acre, i. e., after deducting the cost of feed consumed, and calculating pork at 10 cents per pound live weight, the alfalfa fields, now six years old, produced a net profit of $41.00 per acre in 1914. It would seem conservative to state that swine are able to market alfalfa in the form of pork at a profit unequaled by any other method of handling this famous crop.

Combination Mixtures.

In order to determine the advisability of utilizing an even greater combination of crops for supplying green forage for swine throughout the season, the following mixture was seeded on the half acre area known as field No. 11: Canada field peas, 20 lbs.; oats, 15 lbs.; rape, 4 lbs.; sweet clover, 5 lbs.

This field was utilized for the breeding males, and supplied sufficient forage for four animals averaging 500 lbs. each, throughout the season from June 1st. to October 31st. The oats and peas supplied early forage, and the rape and sweet clover alone survived the dry weather and served as late fall feed. It was observed that this mixture was best suited for foraging when the plants were from nine to eleven inches high, and that close cropping was injurious and should be avoided. The males pastured in this way kept in good flesh without the addition of grain. It is doubtful, however, if the peas and oats added materially to the mixture, and that perhaps the rape and sweet clover alone would have furnished a more palatable feed.

Forage, vs. Pen Feeding.

A number of animals were sold to Squibbs laboratories for use as test pigs in determining the potency and value of hog cholera serum and virus. They varied in weight from 40 to 125 lbs., and were selected from litters confined in pens as well as from litters farrowed and raised in yards where the animals had access to forage crops. It was remarked by the veterinarian in charge of this work at the laboratories that certain animals were very resistant to the disease and that even with an injection of two liters of virus intravenously, the pigs did not "come down" until the dosage had been repeated and even then not until the sixth week. They were running in pens swarming with cholera germs, and pigs sick wirh cholera were pen mates. It was found that the hardiest and most resistant pigs were farrowed from sows that had been housed in the open with only the protection afforded by the colony houses. In addition to this hardiness, they gained more rapidly during the same season period. Furthermore, this concern purchased other pigs from farmers in the vicinity at the same time and treated them with the same amounts of serum, and it was found that in every case they reacted or came down in twenty-one days. Inquiry developed the interesting fact that all such pigs were pen fed and not given free range, nor were they fed on any forage crop. This experience suggests that one of the important means of eradicating disease is by means of breeding animals possessed of great vigor and vitality, and by perpetuating such hardiness by growing them in open yards where forage crops may be harvested at will, and where close confinement at any time in their development is not tolerated. Pigs require dry, not warm quarters during the winter months, and it would seem that we have experienced much more difficulty in keeping the animals cool and comfortable during the summer months than

from exposure and cold during the winter months. Two full sisters (Berkshires) and their litters furnished interesting comparisons. One was "pen fed," the other grown in the open yards with the breeding herd. Both received the same kind and amount of feed and were mated with the same male. The sow given free range farrowed eight strong vigorous pigs: the other farrowed a litter of six, three of which were small and puny. Those from the free range sow weighed 90 lbs. when sold to the serum plant, those from the pen fed sow averaged 70 lbs. The former were not only more hardy and resistant, but yielded an income of $2.00 more per head.

Mineral Mixtures.

A great many farmers object to giving swine the freedom of a pastured area since the animals habitually "root" and thus disturb the sod or other plants furnishing green forage. To this end an endeavor was made to determine, if possible, if there was any means of checking or controlling this habit, and if it was really necessary to have the pastures littered up by such practices. To this end it was proposed to try out a number of mineral mixtures with the hope of supplying the animals with those ingredients for which they were searching, in such form and in such quantities as would satisfy this craving and thus stop the rooting habit. Likewise, it was assumed that animals practicing this habit were apt to be troubled with internal parasites. It was proposed to make sure that there was no trouble from this source.

At the outset all animals were given in the feed daily for five days in succession, 1 dram of ferrous sulphate for each 100 lbs. of live weight. In a few cases this dosage was doubled and continued over a ten day period, and in either case followed by a laxative feed such as molasses or bran and oil meal mash. Furthermore, all animals were dipped in a 2 per cent. solution of creolin, to which had been added, on the surface, a coating of crude oil. This insured against external pests or lice. In case a suitable dipping tank is not available the crude oil may he applied by means of using a piece of waste saturated with crude oil and going over the animals thoroughly. The following mixture was kept before the animals at all times, being placed in a low box where the pigs would habitually frequent:

Charcoal (either wood or charred corn cobs), 1 bu.; salt, 25 lbs.; bone meal, 50 lbs.; oil meal, 25 lbs.; air slacked lime, 25 lbs.; gentian, 5 lbs.; sulphur, 5 lbs.; ferrous sulphate, (powdered), 5 lbs.

At the outset shelled corn was sprinkled in or near the box to attract the animals. It was found that unless the box was protected in some way against rain that a pasty unpalatable mass would form that the animals would not touch, and that it was an advantage to protect the box from rain, and add a fresh supply at frequent intervals.

Furthermore, rings were placed in the noses of all pigs at the very outset when they were turned into the fields, and care exercised to keep them off the field when the ground was very wet and soft. In

this way it was possible to eliminate almost entirely the rooting annoyance. Plots Nos. 1-3-4-5-6-7-8-9 and 10 did not not show a trace of rooting while Nos. 2 and 11 where the mixture was not used was badly uprooted.

The mixture is inexpensive, and when used in conjunction with a well balanced ration there is no need for unsightly disturbances resulting from habitual and persistant rooting.

Wintering Brood Sows.

The chief concern in most breeding operations is production and reproduction. With swine it is the production of pork economically and the reproduction of large, healthy litters that will continue the cycle of life and function. To this end, notably with swine, three factors determine the animals usefulness. First, the method of housing; second, the system of feeding and third, the nature and kind of exercise afforded. Brood sows on the average farm are too fleshy at breeding time, are fed corn extravagantly and very often quartered in small areas that soon become filthy and unhealthy.

Two years ago the plan of utilizing the colony house for wintering brood sows was instituted at this Station. Three or four houses were grouped, faced toward the south, and covered with straw or corn fodder as a protection against draught and exposure. During the winter of 1913, fifteen brood sows were wintered in this way. Three frame houses 8′ x 8′ were used, two with wooden floors and one without such protection from ground exposure. Empty beet pulp bags were weighted and tacked over the doorways to keep out the snow and rain. The one without any floor was most frequented by the sows. The bedding, (shavings) was always dry and the houses appeared to supply every comfort desired by the brood sows.

The houses were located about three-hundred feet from the feeding troughs, which necessitated regular exercise coming to and fro at feeding times. This factor alone had many advantages. It enabled the care taker to detect promptly any evidence of sows re-appearing in use; the sleeping quarters as well as the feeding areas were always clean and free from voidings, while the sows in every case looked thrifty and healthy, and all were mated with promptness and surety during the breeding season.

Their only ration was ear corn and alfalfa hay—all the latter that they would clean up with relish, alfalfa hay in slat racks being kept before them at all times,—with enough ear corn to keep them gaining approximately one-half pound per day. The sows were notably thin, but vigorous at mating time. Considering both cost and convenience this practice recommends itself, while in the case of the Station herd the sows are especially hardy, and the breeding records appearing elsewhere in this report, show large and healthy litters.

It was found that the best pigs could be traced to the brood sows giving the most milk, and that sows farrowing in good flesh were the

heaviest milkers. To this end the grain ration was increased after the sow or gilt was safely settled, say forty-five days after mating. At farrowing time the sows were all in good flesh and bloom. The corn and alfalfa ration was supplemented with some bran and tankage during the five weeks preceding farrowing. The corn was taken away, entirely, two weeks before parturition and the amount of feed increased in bulk by the use of pulped roots and alfalfa leaves. The sows were again placed on full feed (all they would eat and clean up with relish) when the pigs were four weeks old.

An attempt was made to combine the feeding of alfalfa hay after farrowing, but it proved too bulky and the sows lost flesh and failed to give a satisfactory flow of milk. Succulence is required as well as a highly concentrated ration with nursing pigs.

Green rye gave much better results than the alfalfa hay, due no doubt to its succulent properties. The third cutting of alfalfa is much to be preferred for swine feeding, since it is finer in texture, has more leaf development, and is usually sweeter and more palatable. Every swine grower may with economy utilize alfalfa hay to advantage as a part of his home grown ration for brood sows. It is equal to wheat bran as a source of food nutrients and being produced on the farm is a much cheaper source of protein.

Cost of Gains and Maintenance.

With a few exceptions all of the swine in the Station herd are pure bred: the exception being such animals as are used in cross-breeding experiments. However, in order that the calculations may be made on a strictly pork basis, the amounts are inventoried each year on October 31st and the department charged market prices for the food consumed.

The statement dating from October 31st, 1913, to November 1st, 1914 is as follows:

October 31, 1913—Number of animals in herd, 80; total live weight, 10,850 lbs.

October 31, 1914—Number of animals in herd, 162; total live weight, 20,423 lbs.; number of animals sold during the year, 96; weight of animals sold, 9,284 lbs.; number of animals purchased during year, 16; weight of animals purchased, 1,923 lbs.

Deducting the weight of the animals purchased from the totals obtained by calculating the amount produced, less the inventory weight on October 31, 1913, it will be noted that a total of 16,934 lbs. of pork was produced during the year. This calculation is somewhat misleading, for it must be remembered that animals of all ages are included as well as the breeding matrons and males maintained in the herd for breeding purposes. Such animals should be excluded if the actual cost of producing a pound of marketable pork is desired.

The feed consumed by the entire herd during the year was as follows:

	Lbs	Cost per 100 lbs.	Total Cost
Corn Meal	4500	$1 40	$63 00
Shelled Corn	2000	1 25	25 00
Ear Corn	24322	1 00	243 22
Red Dog Flour	14810	1 70	252.28
Ground Oats	9050	1.50	135 75
Wheat Bran	3000	1 30	39 00
Digester Tankage	1700	2 30	39.10
Oil Meal	500	1.70	8 50
Shorts	500	1 40	7 00
Alfalfa Hay	3700	1 00	37.00
Skim Milk	50000	.25	125 00
Total			$974 85

Based on the calculated production of 16,934 lbs. gain in live weight at a cost for feed amounting to $974.85, the cost per pound of gain found to be 5.6 cents per pound. As a matter of fact the total sales for the year amounted to $2,114.39, and this figure does not include the bred sows and breeding males that have been sold and will be ready for delivery during January or February.

Garbage Tankage or "Stick."

The experiment to determine the feeding value of garbage tankage was continued from last year. It was proposed to determine a method whereby the refuse product known as "stick" could be safely fed to pigs. The problem resolved itself into one of making the mixture palatable, for in addition to having an acid reaction, the material, unprepared or untreated would not attract the pigs. It was found that two methods of neutralizing the acidity were practical, one being the use of lime water, and the other material used being ground limestone. The product varied materially in its composition both chemically and mechanically, and for this reason it is not possible to give a definite formula governing the amount of these products required for neutralization. The ground limestone was used freely, the stick product being agitated from time to time in order to thoroughly mix the material. The results of 1913 proved the efficiency of a mixture made up of four parts of cornmeal, eight parts of stick and three parts of black strap molasses. These proportions prevailed, and with the exception of the addition of a small amount of red dog flour the pigs were fed variations of this mixture throughout the season. It was desired to determine whether or not the pigs could be kept on this feed for a long period of time, and it will be noted from Table No. 2, that Lot No. 1 was fed this mixture for ninety-six days, and that they gained throughout this period an average of 1.656 lbs. per day.

It will be noted that No. 5 in Lot No. 3 is the same individual, and is assigned No. 7 in Lot No. 4. He was fed tankage for a total of 122 days, and gained as much during the latter experiment as during the first. It must be remembered that this was an experiment to determine the palatability of this feed, discover such combination mixtures as would appeal to the animals, and enable them to utilize this feed over long periods of time. It was not a question of getting the most rapid gains during the

interval. This mixture proved its usefulness in fattening old sows for market, and there is no question but that this product will eventually be used extensively in swine feeding work. In its present form, however, the stick is too bulky, and not easily handled. It was suggested to the manufacturers that it be dried, and distributed in the form of a powder similar to other concentrated feed products.

Lot No. 5 was fed only ear corn and digester tankage with skim milk as a supplement, and it will be noted that the gains cost ten cents per pound as compared with .0376, .0499, .0599, .0460 cents in lots where the stick was used. It must be added, however, that Lot No. 5 was continued, as a check, past the age and weight when such animals should be marketed, and that throughout this experiment the results show that animals fed the stick-corn-molasses combination were able to make gains at a cost of less than half that resulting from a mixture of corn, digester tankage and skim milk.

Table I.
Feed Consumed.

Lot No.	Animal No.	Ear Corn lbs.	Tankage lbs.	Red Dog Flour lbs.	Stick lbs.	Black Strap Molasses lbs	Skim Milk lbs.	Total Cost of Feed.	Cost per lb. of gain.
1. . .	1 2	464	50	6	560	143	. . . .	12.02	.0376
2. . .	3 4	75	11	56	127	24	. . .	3.12	.0499
3. . .	5 6	302	24	77	343	112½	. . . .	8.90	.0599
4. . . .	7 8	413	29	. . . .	580	150	. . . .	10.82	.0460
5. . .	9 10 11	832	76½	. . . .	. . .	. . . .	990	25.87	.1014

Table II.

Lot No.	Animal No.	Initial Wt. lbs.	Final Wt. lbs.	Net gain. lbs.	Days on feed.	Average daily gain per pig lbs.
1.	1 2	696	1015	319	96	1.656
2.	3 4	524	587	63	22	1.430
3.	5 6	489	638	149	61	1.220
4.	7 8	935	1170	235	61	1.282
5.	9 10 11	325	580	255	101	1.762

Summarized it will be noted with Lot No. 1 that the two animals gained 319 lbs. in ninety-six days at a total cost for feed of $12.02 or .0376 cents per lb.; that Lot No. 2 gained 63 lbs. in twenty-two days at a total cost of $3.12 or at the rate of .0499 cents per lb. Likewise Lot No. 3 produced a net gain of 149 lbs. in sixty-one days, a total cost of $8.90 or at the rate of .0599 cents per lb.; that Lot No. 4 in sixty-one days made a net gain of 235 lbs., a total cost of $10.82 or at the rate of .0460 cents per lb.; that Lot No. 5, being two inbred sows, were on feed one hundred and one days,

gained 235 lbs. or at the rate of 1.762 lbs. per day at a cost of 10 cents per lb. The pigs were off feed at intervals, due to our endeavor to increase the amount of stick in their ration. Circular No. 40 gives in detail the original plan and scope of this experiment.

Breeding Records.

Thirty sows whose records are given farrowed a total of 254 pigs, varying from 4 to 15 per litter, or an average of slightly more than eight pigs per litter. The number of males and females were very evenly distributed, 95 males and 97 females were raised. In this regard it is interesting to note the results of one experiment in inbreeding. Poland China sow known as Rutgers Eleanor farrowed five pigs on May second. She was bred to her full brother, and the breeding records show no inbreeding in the previous generation; however, four of these pigs were totally blind, two of the males carried only one testicle, while one male and one female were apparently normal. The pigs gained very rapidly at the outset, but failed to respond to feed and kind treatment later in the season. Two of them while pasturing in the rape field were stricken with the heat and a third was accidentally killed in the yard. A full sister of this sow was cross-bred with a Duroc-Jersey male and produced a litter of eleven pigs, all of which were normal and vigorous. The Yorkshire sow identified as Rutgers Oak Princess was likewise mated with her full brother, and she produced on Sepember 23rd, four pigs, two of them were crippled, being entirely paralyzed in their hind quarters, and unable to get around without assistance. It was finally necessary to kill the two crippled pigs. The other two were perfectly normal and healthy. A full sister of this Yorkshire sow was mated with a Berkshire and produced a litter of twelve pigs. It would seem from this experience that mating brother and sister is not practical nor profitable in swine breeding operations. Small litters with weak, deformed pigs will result from such mating.

The Hog Cholera Situation

The hog cholera problem is well in hand. Only a few outbreaks were encountered during the year, and less than 25,000 c. c. of serum distributed. Camden County suffered the greatest loss, and outbreaks were reported in Monmouth, Burlington, Somerset, Middlesex, Bergen and Salem, but the prompt use of serum prevented a wide spread of the disease. Squibbs laboratories, located adjacent to the College Farm, have equipped an extensive plant for the production of serum and virus, and arrangements were made with the concern for the prompt filling of all orders for hog cholera serum. In this way the Station was able to co-operate with the Live Stock Commission, and send an inspector into the district where the disease was encountered. In a number of cases owners subjected herds to the double treatment, using serum alone to be followed in ten days with serum and virus. In one case cholera was introduced into the herd by this means, but the outbreak was soon under control. Where it was possible to utilize the serum before the animals were taken sick, practically all the animals treated survived.

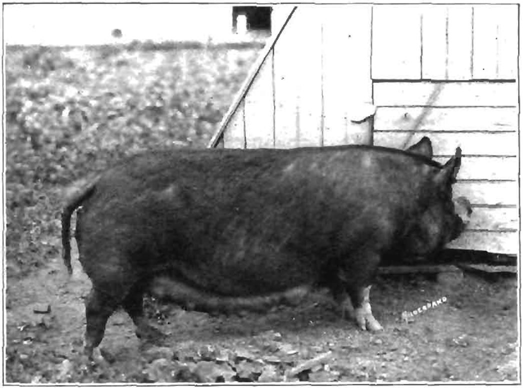
Distribution of Breeding Males.

Very few herds of pure bred and registered swine are found in this state, the bulk of the farmers being satisfied with grade animals of unknown breeding. In Monmouth and Burlington counties the old type of Jersey Red is found, but practically none of the animals are registered in recognized breeders' associations. Inbreeding has been resorted to in many instances resulting in a decrease in size and a lack of constitutional vigor and vitality.

In the hopes of demonstrating the value and usefulness of the pure bred sire in swine breeding operations, the swine department co-operating with the Live Stock Commission and the E. B. Voorhees Agricultural Society arranged to distribute a few sires for mating purposes.

In order to secure a selected boar in any community members of the graduate division of the E. B. Voorhees Agricultural Society assumed responsibility for the care and maintenance of the boar for the year, the Live Stock Commission paid the transportation and inspection charges, while the Experiment Station furnished the pig without cost to the community association. The boars remain the property of the Station, and may be removed at any time for the cause or transferred to other sections of the state if desired. A minimum of twenty brood sows for mating purposes is required before the pigs are assigned to the society representatives. It is hoped that this scheme of co-operation will result in increased interest in pork production and that it will be a means of introducing and establishing permanently the use of the registered sire in all breeding operations.

Brood sows with litters pasturing on Rape and Sweet Clover and utilizing colony houses.



ROOKWOOD LADY 48TH.—Produced 20 pigs during year. A useful type of brood sow now in Station herd.

Report of the Poultry Husbandman.

HARRY R. LEWIS, B. S., *Poultry Husbandman.*
WILLARD C. THOMPSON, B. S., *Assistant in Research.*

The work of the Department of Poultry Husbandry for the year 1913-14 has progressed in a very satisfactory manner. This is especially so in view of the nature and extent of the research work. A number of new projects have been started and work already under way has been continued. The data secured show some very conclusive results. The Research Department has been handicapped by the fact that the work has been financed with decreased appropriations, but in view of an exceptionally gratifying income from commercial sales and help rendered the Department from General Station funds the projects have not been seriously crippled. The following report will present the work of the Department under three distinct heads: (1) Administration; (2) Research; (3) Extension.

ADMINISTRATION.

Personnel.

The Poultry Husbandman wishes, at this time, to express his appreciation to all members of the Poultry staff for their hearty co-operation in the work of the Department. The research work has been especially successful owing to rhe fact that one man's time has been entirely devoted to the details involved. The development of the Extension work has been somewhat handicapped owing to the fact that Mr. A. L. Clark, who was devoting his entire time to that phase of the work resigned during the year to take up institute and extension work under the Smith-Lever bill. His work was done by other members of the Department in so far as time would permit. At the close of the current year an important addition to the working staff was secured through the appointment of Mr. Victor G. Aubry to the position of Poultry Specialist in Extension work. Mr. Aubry is a graduate of The Connecticut Agricultural College, and comes to the Department after having served for two years as Head of the Poultry Department of the University of Maine. Under his direct charge

the Extension operations will be enlarged and carried on in a more complete and systematic manner. The following is the make-up of the Staff of the Poultry Department as it exists November 1, 1914:

Harry R. Lewis, Poultry Husbandman, Victor G. Aubry, Extension Specialist; Willard C. Thompson, Assistant in Research; Morris Siegel, Foreman, Elmer H. Wene, Assistant; Mary B. Reed, Stenographer; Kathryn L. Reed, Statistician.

Plans for Future Development.

Owing to the encroachment of the campus upon the land which had been previously set aside for poultry work it has been deemed wise to move a portion of the buildings to an adjacent location. The College has set aside a large acreage for this purpose, which will be described and discussed later. It is the plan to retain on the present location the Administration building and all incubation and brooding equipment. The State Legislature made an appropriation during its last session of $6,500 to begin the moving and remodelling work. In order to complete the work and to put the Department in finished condition in so far as equipment is concerned, it will be necessary to secure an additional appropriation from the present Legislature of not less than $10,000.

A three-acre tract adjoining the present poultry plant has been set aside as a specimen or type poultry farm. This area will contain thirty pens, all uniform and laid out systematically with roads and lawns. Each pen will contain a special mating of the more common breeds of poultry. From 20 to 25 distinct varieties will be represented. It will be planned to use this equipment entirely for educational and demonstration purposes. Many of the birds in these pens have been contributed by the leading poultrymen in the State. The following is a list of the contributors:

Single Comb Rhode Island Reds, J. F. Bouton, Blairstown, N. J.
White Wyandottes, Acme Poultry Farm, J. Harry Wolsieffer, Vineland, N. J.
Columbian Wyandottes, Sunnybrook Farm, Chas. D. Cleveland, Eatontown, N. J.
Partridge Plymouth Rocks, Wilburtha Poultry Farm, Chas. E. Fiske, Trenton Junction, N. J.
Buff Orpingtons, Sunswick Poultry Farm, Rufus Delafield, South Plainfield, N. J.
White Leghorns, Monmouth Farms, J. Courtney Punderford, Freneau, N. J.
Buff Leghorns, Monmouth Farms, J. Courtney Punderford, Freneau, N. J.
Mottled Anconas, P. W. Logan, Woodbridge, N. J.
Silver Campines, M. R. Jacobus, Ridgefield, N. J.
White Silkies, Sunswick Poultry Farm, Rufus Delafield, South Plainfield, N. J.
Fawn and White Indian Runner ducks, C. E. Valentine, Ridgewood, N. J.
Light Sussex, Dr. F. K. Conrad, Hackensack, N. J.
English S. C. W. Leghorns, R. G. Lank, Twin Oak Farm, Downingtown, Pa.
Columbian Plymouth Rock, Wilburtha Poultry Farm, Chas. E. Fiske, Trenton Junction, N. J.

The Poultry Husbandman wishes, at this time, to express his appreciation to these persons who have so heartily co-operated in making this most excellent display of the various breeds of poultry possible.

It is hoped that during the ensuing year a number of different breeds of ducks, geese and turkeys may be added.

With the completion of the new poultry farm, as described in the following paragraph, another step toward the completion of an equipment in keeping with great poultry industry in the State will have been taken. Owing to the increasing popularity of the Poultry Courses, both in the Long Course and in the Short Course the present administration and instruction building is inadequate to the needs of this work. One of the most urgent needs of the Department for the immediate future is a new poultry husbandry building, to contain laboratories and lecture rooms, together with offices and equipment necessary to house the many departments of the work. A plan of construction has been developed involving three isolated buildings, arranged in form of a group, viz: a large administration building in the center to cost $60,000 and laboratory buildings on either wing, to cost $25,000 each. The Administration building is needed immediately; the buildings on either wing can be added from time to time as the work enlarges.

The New Poultry Plant.

The work of laying out and developing the new poultry farm which was briefly referred to in the last annual report has progressed slowly. The entire area of 20 acres has been surveyed, the roads have been laid out and the entire tract has been fenced with an 8-foot woven wire steel construction, surmounted by 4 strands of barbed wire on off-sets. This fence will not only protect the experimental work from the possibility of theft and interruption, but will also serve to keep rodents and injurious animals from running over the plant. The fence used was Elwood specification, small mesh, non-climbable fence, and was furnished to the Department at cost by the American Steel and Wire Company of New York City.

On the new poultry farm will be located all the ranges for the growing stock and all the pens for the laying birds. The incubation and brooding operations will still be performed on the present location on Nichol Avenue. The range area covering 5 acres is located in a young oak and locust forestry nursery. The area is divided into 19 separate ranges, each provided with running water. Suitable summer shelters for the growing stock have been built. A low marshy area in one corner of the farm has been dredged and laid out in the form of

a circular pond with an island in the middle, about which the duck houses will be located.

Five acres of the total area have been set aside as a special breeding farm. On this will be located 54 individual breeding pens, each pen being 6x10 feet, constructed as double pen houses, each with a large yard which is at present seeded to alfalfa. All of the large laying houses have been located and the foundations are at present under construction. It is planned to have them built before freezing weather, and to move all the houses to their new location the first thing in the Spring. All drives and paths have been planned so that an automobile or carriage can drive about the farm and the occupants inspect all the flocks without leaving the conveyance. With the completion of this poultry farm some time during the next year it is believed that the Poultry Department of the New Jersey Agricultural Experiment Station will have as efficient a poultry plant as that possessed by any State or Federal Institution of its kind. For a plan of the lay-out see last year's annual report.

Financial Statement

The following is a financial statement of the cash and credit sales from the Department during the year from November 1, 1913, to October 31, 1914. The work of moving the plant, which has already been started, has had the effect of curtailing the production. It is expected, that during the year, on account of the necessity of changing the flocks, a number of times during moving, production and hence revenue will suffer.

Financial Statement for Year 1913-1914.

INCOME BY MONTHS—November, $230.23; December, $267.34; January,$349. 15; February, $345.80; March, $317.96; April, $541.05; May, $378.85; June, $565.54; July, $418.13; August, $350.51; September $207.64; October, $283.51; total, $4,255.71.

This amount more than covered the cost of feed and labor for the plant.

No attempt is here made to give an accurate inventory, as the birds have been changed continually during the process of moving the plant and they have also been reduced considerably in number to facilitate moving.

Commercial Aspects of an Experimental Flock.

In a study of the previous financial statement and also a statement for the year 1912-13 which appeared in the previous annual report, two things are of interest; first, the large revenue which has been secured in proportion to the number of birds kept; and, second, the

fact that all products sold have been disposed of to wholesale markets with the exception of a limited amount which is sold to the College Faculty and members of the Station staff. The income is very gratifying, especially so in view of the fact that over 50 per cent. of the hens constituting the flocks are being fed or managed with a purely experimental object in view. By that I mean that many of the flocks are fed rations deficient in protein, or are kept under conditions which we know are not the best, with the idea of determining good and bad methods of management, complete and incomplete rations, etc. The function of the Experiment Station flock should be to determine facts of such a nature that the results will be of benefit to the poultry farmers in the State. We hope to do this regardless of the loss, in order that by this single determination thousands of poultry farmers can apply the results without subjecting themselves or their flocks to the losses following such trials. It is not the plan of the Poultry Department to run a commercial flock, but through judicious management and the sale of surplus stock it was possible to dispose of the products to the best commercial advantage, and hence utilize the revenue secured for more complete investigations.

Activities of the Department.

The activities of the Poultry Department naturally group themselves as follows:

EDUCATIONAL—Poultry instruction in the 4 year courses in Agriculture as offered by Rutgers College. Twelve weeks short course in Poultry Husbandry as offered by Rutgers College. Poultry instruction in the summer school as offered by Rutgers College. A systematic reading course offered to individuals in the State through Educational associations. Institute and extension lectures. Publication of circulars and bulletins.

RESEARCH—Research experiments conducted on the Station plant. Laboratory experiments of a preliminary nature conducted on the Station plant. Observations and comparisons as to different methods of management. Co-operative experiments conducted on poultry farms in the State.

ADVISORY—Correspondence through the answering of inquiries by mail. Trips of inspection at owner's request. Examination of diseased and sick birds.

STATISTICAL—Compilation of a poultry census of New Jersey. (a) *The location of large centers of production.* (b) *A card file of*

poultry flocks with complete data. (c) The financial condition of the industry.

I mention briefly the educational work of the Department at this time because, of necessity, it is closely associated with the general activities of the Department. This year three students are specializing in Poultry Husbandry in the Four Year course in Agriculture. Forty students are enrolled in the Winter Short Course in Poultry Husbandry, which is just convening. Owing to the increasing demand for poultry instruction the Department has recently secured the services of *Mr. C. E. Brett* as instructor in Poultry Husbandry. Mr. Brett is a graduate of the Rhode Island Agricultural College, and has for a number of years successfully managed large flocks of poultry. Mr. Brett, while engaged primarily in instruction, has been of material benefit to the Department in general advisory work. He has answered much correspondence pertaining to types and breeds of poultry and has made many inspection trips.

Twelve numbers of the regular monthly publication "Hints to Poultrymen" have been issued. The following is a list of those issued, together with the authors. These publications are sent to the Poultry Organizations in the State and are by them distributed to the individual members. From 2,500 to 3,000 copies of each number have been printed each month. It is believed that this line of effort has been more productive of real results than any of the publication activities of the Department.

October, 1913, New Jersey Dry Mash Hopper, A. L. Clark; November, Management of the Breeding Stock, A. L. Clark, December, Chicken Pox, Roup and Canker, H. R. Lewis; January, 1914, Vigor and its Relation to Production and Growth, H. R. Lewis; February *Pedigree Poultry Breeding, H. R. Lewis, March, Brooding Devices, A. L. Clark; April, The* Proposed State-Wise Co-operative Egg Marketing Plan, A. L. Clark; May, The Summer Management of Growing Stock, W. C. Thompson, June, Summer Management of Mature Fowls, A. L. Clark; July, Summer Parasites of Poultry, W. C. Thompson; August, The New Jersey Plan of Co-operative Egg Marketing, H. R. Lewis and A. L. Clark, September, Local Poultry Associations, H. R. Lewis and A. L. Clark.

The following is a list of subjects which will be presented in the form of "Hints to Poultrymen" for the year 1914-15.

October, 1914, Sanitation and the Poultry Flock, W. C. Thompson; November, Caring for the Poultry Flock, H. R. Lewis; December, Sprouted Oats for Winter Succulence, C. E. Brett; *January, 1915, The Business End of Poultry Keeping, H. R. Lewis; February*, Green Crops for Rotation in the Poultry Yard, W. C. Thompson, March, The Sitting Hen, C. E. Brett; April, Preserving Eggs for Home Use, V. G. Aubry; May, Mangel Beets for Poultry H. R. Lewis, June, Summer Poisoning, W. C. Thompson; July, Quality in Poultry, V. G. Aubry; August, The New Jersey Small Flock Poultry House, C. E. Brett; September, The Fall Management of Pullets, V. G. Aubry.

One research bulletin has been issued, the subject being "The Ash and Protein Factors in Poultry Feeding."

The following circulars have been published and have been used largely in the answering of correspondence and for dissemination upon

request: Poultry Rations and Methods of Feeding, Poultry Farming, A Diversified Industry, Winter Egg Production, and Rearing Chickens.

The Poultry Department has been represented at a number of conventions, among them being the Annual Convention of the American Association of Instructors and Investigators in Poultry Husbandry which was held at MacDonald College, St. Anne de Bellevue, Canada in the Summer of 1914. At this meeting the Poultry Husbandman presented a paper on "Sex Limitation and the Barring Factor"; W. C. Thompson a paper on "The Ash and Protein Factor in Chick Feeding"; and Mr. A. L. Clark a paper on "Poultry Organizations for Educational Purposes." The Poultry Husbandman also attended the annual convention of the American Society of Animal Production, and presented a paper on "The Protein Nutrient in Feeding for Egg Production."

In addition to the regular publications of the Department, different members from the Poultry staff have from time to time, prepared press notices in the form of popular articles for publication in Agricultural and Poultry journals. These articles have covered the practical application of the results of completed poultry investigations.

Research.

As was previously mentioned the research work of the Department has been productive of some very interesting, valuable and practical conclusions. An effort has been made to standardize all research work. With this in mind the experimental work has been outlined and conducted as 2 distinct types viz: research projects and observation projects. The former includes all definite lines of investigational work which are of a scientific nature, and which are outlined to continue for a period of years. The observation project covers short experiments which are conducted from time to time to prove methods of management, and do not require any great amount of detailed application. All projects, whether research or observation are definitely outlined before the work is started on blanks provided specially for that purpose.

Monthly summarized reports are made out and filed, these containing general conclusions for the period, and index references to detailed records are kept. This system has made possible the conducting of a greater amount of work in a satisfactory and systematic manner.

The research projects of the Department include three distinct problems viz.: questions pertaining to poultry feeding, poultry housing

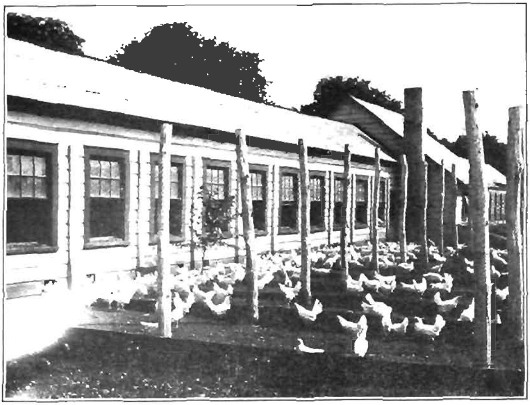
and breeding. The following are some of the detailed results secured in the feeding projects.

Sour Skim-Milk as a Supplementary Food for Growing Chicks.

During the past year the work with sour skim-milk as a supplementary food for growing chicks was continued on a more extensive basis than was possible during the previous year. The object of the work was to determine the specific value of sour skim-milk as a protein food for chicks during the early stages of development and growth. Many poultry farmers have long recognized the value of milk products in poultry feeding, especially for fattening fowls, but little attention has been given to the use of milk products in the feeding of small chicks.

Skim-milk, according to Snyder's Dairy Chemistry, has a composition about as follows: water, 90.25 per cent.; fat, 0.20 per cent.; casein and albumen, 3.60 per cent.; milk sugar, 5.15 per cent.; ash, 0.80 per cent.

The percentage of fat will vary according to the efficiency of the separator which has been used in removing the cream from the whole milk. This composition shows that skim-milk is quite rich in food materials, and consequently might be expected to be a good poultry food. The sweet skim-milk is an almost impractical proposition for the average farmer, especially during the warm months of the year. All milk contains certain bacteria which cause that condition known as souring. These bacteria work especially fast during the warm months, and thus it is very hard to keep milk sweet under the average farm conditions. Because of this the question as to the value of sour milk has been raised. In the belief that it is always better to feed either all sweet milk or all sour, the latter was chosen as the form of milk to use in this particular line of work. This was the practical reason why the sour skim-milk was used. From the standpoint of chemistry it has been found that during the process of souring, or fermentation, some of the milk sugar is transformed into lactic acid, and a part of the casein is transformed into simpler materials, which are more easily digested than the ordinary casein. Therefore, sour skim-milk is a food which is very easily digested and more quickly used by the delicate system of the young chick. Certain investigators have pointed out that during the early life of the chick there were not secreted in the intestinal tract those juices which are necessary for the digestion of the materials found in sweet milk, but that the juices



The Single Comb White Leghorn chicks in these flocks were used in the tests of sour skim-milk as a supplementary food for growing and developing chicks. All flocks were fed the same basal ration, naturally soured skim-milk being added to the rations of four pens, Bulgaricus soured milk to the rations of another series of four pens, and no sour skim-milk to the remaining.

present were capable of digesting constituents of milk after it had been soured by the bacteria. Skim-milk that has been allowed to sour naturally usually contains from 0.80 per cent. to almost 1.00 per cent. of lactic acid. There has been on the market during the past few years a commercial product known as Bulgalactine. This appears in the form of small tablets which contain active Bulgaricus bacteria. These bacteria were used for the purpose of souring milk, producing from 2 per cent. to 3 per cent. of lactic acid as against the small amounts produced by the normal organisms in milk. The presence of this large amount of acid has been thought to have a beneficial effect upon the digestive tract of the chick. Probably an increased percentage of lactic acid would mean that a larger amount of casein would be reduced to a simpler form. The increased percentage of lactic acid has also been supposed to have a very detrimental effect on any disease organisms that might be found in the digestive tract. In this experiment the effect of the lactic acid upon disease—producing bacteria was not studied as the whole experiment was conducted from the nutrition standpoint alone. The preparation of the milk soured by Bulgaricus organisms required simmering the milk for 45 minutes and then cooling to 103 degrees F. before introducing the Bulgalactine. This process killed all natural organisms and left the milk free from souring bacteria. Thus it was possible to sour the milk by the Bulgaricus organisms alone, this process being undergone each day.

Ten pens were used, each flock containing 42 single comb White Leghorn chicks. All chicks were placed in the pens as soon as ready to be moved from the incubators. The various flocks were as uniform as it was possible to obtain, all weak chicks being discarded. The food consumption was measured from their first meal throughout the entire 9 weeks of the experiment. Two of the pens received no sour skim-milk whatsoever, four pens were allowed free access to ordinary sour skim-milk, and four pens were allowed access to skim-milk soured by the Bulgalactine tablets. All pens were fed the same grain ration at regular intervals which consisted of fine cracked corn, 40 lbs.; fine cracked wheat, 40 lbs.; rolled oats, 20 lbs.

All chicks had free access to the same dry mash which consisted of wheat bran, 50 lbs.; gluten feed, 10 lbs.; corn meal, 10 lbs.; ground oats, 10 lbs.; meat scrap, 8 lbs.

The chicks were kept in the brooder house for a period of 9 weeks; and each flock was carefully weighed at the end of each week. The following table No. 4, gives the average weight of the chicks at the

end of each week, measured in ounces; it indicates the comparative gains which were made by the various flocks.

Table No. 2 gives the weekly consumption of grain of each pen, measured in ounces.

Table No. 2.
Weekly and Total Consumption of Grain, in Ounces.

Week.	Brooder Pen No									
	11	12	13	14	15	16	17	18	19	20
1	66	78	66	66	66	66	66	66	66	56
2	61	97	84	97	97	97	97	97	97	97
3	100	100	100	100	100	100	100	100	100	100
4	139	112	141	115	151	151	148	148	128	157
5	114	108	129	127	129	125	123	123	129	129
6	96	98	132	120	120	132	108	132	132	132
7	192	174	204	192	198	180	180	192	192	192
8	180	198	216	210	210	216	216	216	216	216
9	174	162	216	216	216	216	216	216	216	216
Total	1983	1257	1288	1275	1288	1281	1254	1291	1297	1290

(Each dot in the above table stands for one-quart ounce)

Table No. 3 gives the weekly amount to dry mash placed in the hoppers of each pen, measured in pounds.

Table No. 3.
Number lbs. Dry Mash Supplied Each Pen.

Week	Brooder Pen No									
	11	12	13	14	15	16	17	18	19	20
1	7	7	7	7	7	7	7	7	7	7
2	2	2	5	5	5	5	5	5	5	5
3	6	6	6	6	6	8	6	6	10	8
4	8	8	8	8	11	10	8	11	8	11
5	12	12	12	16	12	12	16	12	16	18
6	10	6	14	16	14	14	10	16	14	10
7	12	12	12	12	16	16	16	12	12	16
8	12	8	16	16	12	12	12	12	16	12
9	12	12	16	16	16	12	12	12	13	9
Total	81	73	96	102	99	100	92	93	91	96

At the close of the ninth week the chicks were taken from the brooder. All cockerels weighing over one pound were sent to Philadelphia as broilers, and all pullets were placed upon the peach orchard range for the remainder of the summer. No attempt was made to determine the total market value of the different birds from the different pens. That determination remains for more extensive work which is planned for the coming year. The object of this work was simply to observe the difference in the rate of growth in the chicks receiving no sour skim-milk, those receiving natural sour skim-milk and those receiving skim-milk soured by Bulgalactine tablets. (Table 4.) In addition to this, data was taken as to the relative consumption of grain and mash in each flock.

Table No. 4.

Average Weight of Chicks, in Ounces, at End of Each Week.

Week	Brooder Pen No				
	11	12	13	14	15
1	2, 10/14	2, 13/21	2, 9/11	3, 1/6	3, 5/42
2	3, 13/14	4, 37/42	4, 19/42	4, 35/42	4, 8/21
3	5, 34/41	5, 2/3	6, 25/42	7, 1/6	7, 1/3
4	7, 25/41	7, 3/14	8, 3/7	9, 1/21	9, 5/21
5	8, 9/10	8, 11/42	10, 4/41	10, 5/14	10, 25/41
6	10, 5/8	10, 1/19	12, 29/41	13, 23/40	13, 1/4
7	12, 27/40	12, 7/37	16	15, 31/39	15, 39/41
8	14, 10/41	14, 1/19	18, 3/20	20	19, 2/41
9	16, 2/13	16, 1/9	15, 31/41	16, 15/19	20, 3/7
Week	**Brooder Pen No**				
	15	17	18	19	20
1	2, 20/21	3	2, 13/16	3	3, 1/7
2	4, 5/14	4, 31/42	3, 5/21	4, 31/41	4, 19/21
3	7, 3/7	6, 41/42	6, 22/41	7, 1/41	7, 1/14
4	9, 1/13	8, 2/3	8, 10/41	8, 2/5	8, 29/41
5	10, 31/41	10, 7/40	9, 31/41	10, 17/41	10, 18/41
6	13, 26/39	13, 8/39	12, 2/13	12, 20/41	12, 13/20
7	13, 9/45	14, 9/10	15, 1/3	15, 12/41	15, 17/40
8	19, 17/39	17, 33/41	18, 12/19	18, 2/5	18, 1/2
9	20, 17/20	20, 7/20	20, 10/19	20, 26/39	20, 3/20

A study of the foregoing tables and a general consideration of the results of this experiment seems to justify the following conclusions.

1. Sour skim-milk appears to be a very palatable food for young chicks. There did not appear to be any appreciable difference between the palatability of the naturally soured skim-milk and the Bulgalactine milk, as the chicks in all pens receiving these types of sour skim-milk appeared to be very fond of it.
2. The sour skim-milk formed a source of easily digested protein, a material that is essential to the uniform and continuous development of the chick, as the body of the chick is composed largely of protein materials.
3. The chicks receiving sour skim-milk consumed a larger amount of mash, and on the average more grain. This increased consumption of food meant an increased rate of growth.
4. The sour skim-milk seems to increase the appetite and consequently the consumption of food, and the power of the chicks to use greater amounts of food economically.
5. Chicks receiving the sour skim-milk made a larger and more uniform gain than those not receiving it. In the two pens that did not receive sour skim-milk of any kind the chicks were very noticeably uneven at the close of the period, whereas the chicks in the remaining eight pens were considered very uniform.
6. The milk-fed chicks appeared brighter and healthier at the close of the experiment than did the others.
7. There was little if any difference between the chicks that received natural soured skim-milk and those receiving the Bulgalactine skim-milk.
8. The boiling and preparation of the Bulgalactine milk took considerable time for which there appeared to be no extra benefit.
9. There was lower mortality in all milk-fed pens than those not receiving milk.

High vs. Low Meat Scrap Content in the Ration.

In the Annual Report for the year 1913, the first year's record of the birds in this experiment was written up in some detail. The same pens of Single Comb White Leghorns were continued throughout the past year, which was their second year of laying, upon the same rations which they had received during the pullet year. They were divided as before, into two flocks, both of which were kept in houses of similar type and under similar environmental conditions. One pen received a ration which contained 25 per cent. of meat scrap and the other received a ration which contained 10 per cent. of meat scrap. The scratch grain ration was similar in both cases. The meat scrap was added to the dry mash. During the first or pullet year, the birds *receiving a higher percentage of meat scrap were far ahead of those* receiving the lower percentage, producing many more eggs and at a much greater profit without injuring the birds to any appreciable extent, nor affecting the hatchability of the eggs. On the contrary, however, the vigor and vitality of the flock was noticeably better and the hatchability of the eggs was more uniform and satisfactory. It has been interesting to follow the record of these same birds through the second year of production. The following table No. 5 gives the production of these two pens for the year, and table No. 6 expresses the percentage of production for each month of the year.

Table No. 5—Number of Eggs Laid.

Pen No. 54—November, 31; December, 56; January, 74; February, 243; March, 686; April, 811; May, 817; June, 457; July, 325; August, 304; September, 299; October, 104; total, 4,207.

Pen No. 55—November, 65; December, 83; January, 96; February, 351; March, 711; April, 740; May, 740; June, 477; July, 384; August, 385; September, 216; October, 122; total, 4,370.

No. 54 received 25% meat scrap. No. 55 received 10% meat scrap.

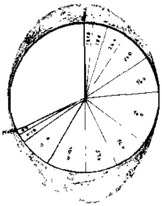
Table No. 6—Percentage of Egg Production.

Pen No. 54—November, 2.4; December, 4.2; January, 5.5; February, 20; March, 51; April, 69; May, 67; June, 39; July, 26; August, 25; September, 9.1; October, 26; total,

Pen No. 55.—November, 2.9; December, 6.2; January, 7.2; February, 29; March, 53; April, 53; May, 55; June, 36; July, 28; August, 28; September, 9.6; October, 17; total.

The mortality has been greater in the pen receiving the higher percentage of meat scrap during the past year. The deaths were due to common winter and spring troubles, such as aggravated cases of roup and chicken pox. Some of the birds in the pen did not appear to have strength and vitality necessary to ward off the fatal effect of this disease. One or two birds died during the summer on extremely hot days. It will be noticed by studying the above tables that pen No. 54 receiving 25 per cent. *of meat scrap fell somewhat below the* other pen, except during the months of April, May and September.

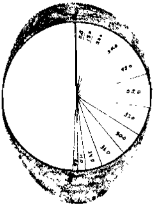
FIGURE 2a.—Percentage of Egg Production.



1912-1913.

25% Meat Scrap Pen

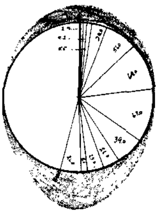
FIGURE 2b.—Percentage of Egg Production.



1912-1913.

10% Meat Scrap Pen.

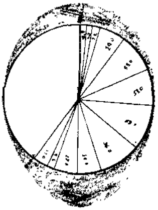
FIGURE 3a.—Percentage of Egg Production.



1913-1914.

25% Meat Scrap Pen.

FIGURE 3b.—Percentage of Egg Production.

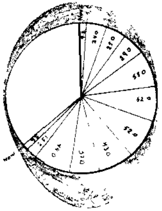


1913-1914.

10% Meat Scrap Pen.

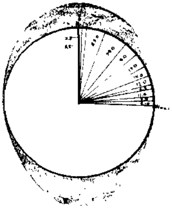
Note—Each division represents one month, the year extending from November 1st to November 1st.

Figure 4a.—Percentage of Egg Production.



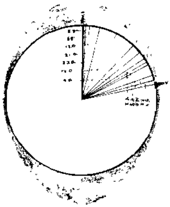
Meat Scrap Pen.

Figure 4b.—Percentage of Egg Production.



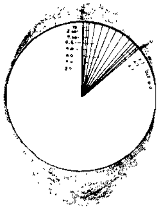
Soy Bean Meal Pen.

Figure 4c.—Percentage of Egg Production.



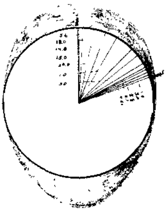
Oilmeal Pen.

Figure 4d.—Percentage of Egg Production.



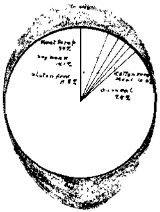
Gluten Meal Pen.

Figure 4e.—Percentage of Egg Production.



Cotton-seed Meal Pen.

Figure 4f.—Percentage of Egg Production.



All Pens.
(Yearly Average.)

Note—Each degree represents 2%.

From the general condition of the birds in these two pens during the year and from their production the following conclusions seem justified:

1. An increased percentage of meat scrap in the ration of laying pullets resulted in an increased egg production during the pullet year.
2. The increased cost of the ration was more than offset by the value of the increase in production.
3. During the first year the increased percentage of meat scrap showed no detrimental effects upon the vitality of the fowls, but rather on the contrary gave them increased vigor.
4. The forced production of the pullet year was not resultant in a continued high production during the second year.
5. The birds receiving a lower percentage of meat scrap during the first year, or in other words, those which were not forced for production during the first year, kept up a uniform production throughout the second year, not noticeably dropping as in the case of the birds receiving the higher percentage of meat scrap.
6. The birds in pen No. 54 seemed to have been somewhat broken down by the heavy production during the second year.
7. From these results, it would seem that the forcing of birds during their pullet year for high egg production is justified. During the second year these birds might well be kept for breeders, in which case they would receive a lower percentage of meat scrap and no attempt would be made to force egg production during this year.

These birds will be continued upon the same rations throughout at least another year of production. It is planned to run the same experiment again with other flocks of fowls in order to check carefully the results of this work. This question of the percentage of meat scrap to advise is one of great importance to the practical poultry feeder and one which should be thoroughly studied.

Vegetable Source of Protein.

For the last few years poultrymen have been realizing more and more the value of high protein foods for laying hens. They have come to appreciate the fact that in order to obtain eggs, which are themselves bundles of protein, it is necessary to furnish the laying hen, which is a veritable machine, with the kind of material that she needs in order to produce eggs. Meat scrap, a high protein food from an animal source, has been quite universally used and with great success. In many sections of the country poultrymen have found it very convenient and economical, at least so they thought, to use protein feeds from vegetable sources not being able to obtain meat scrap. Little, however, has been definitely known regarding the true value of these high protein foods from vegetable sources. Because of this fact a vegetable protein experiment was started at the beginning of this year.

Four practical sources of vegetable protein were used, namely, soy bean meal, gluten meal, oil meal and cotton seed meal. These are all

materials which can be obtained in nearly every part of New Jersey, and are food stuffs that are relatively high in protein. The following table gives the composition of these materials as stated by Henry in his "Feeds and Feeding."

Table No. 7.

Composition of Feeds—Number lbs. in 100.

Soy bean meal—crude protein, 29 1, carbo-hydrates, 23 3, fat, 14 6.
Gluten Meal—Crude protein, 29 7, carbo-hydrates, 42 5; fat, 6 1.
Oil Meal—Crude protein, 31 5, carbo-hydrates, 35 7, fat, 2 4
Cotton Seed Meal—Crude protein, 37 6; carbo-hydrates, 21 4, fat, 9 6
Meat Scrap—Crude protein, 66 2, carbo-hydrates, 0; fat, 13 4.

Single Comb White Leghorn pullets were used for this work, fifty pullets being placed in five pens that were identical in size and equipment. The only varying factors were the protein foods furnished. In the first pen the source of protein was meat scrap, or animal protein. In the second 33 per cent. of soy bean meal was placed in the dry mash. In the third 33 per cent. of gluten meal, in the fourth 33 per cent. of oil meal, and in the fifth 33 per cent. of cotton seed meal was placed in the dry mash. All pens received the regulation Station grain mixture.

The following tables, No. 8 a, b, c, d, e, gives the egg production for these various pens for the first or pullet year, and shows the consumption of mash and grain. One year's record is not taken as proof of anything. These birds will be continued in this same experiment for three years before any specific statements will be made. The figures which are given call attention to the results of the first year's work.

Table No. 8a—No. 42 Meat Scrap Pen.

MONTH.	Nov. 1913	Dec.	Jan 1914	Feb.	Mch	Apr	May	June	July	Aug	Sept.	Oct.	Total.
Eggs laid.	138	361	381	408	810	754	758	609	544	566	193	74	5,596
Mash.	30	68	82	61	77	90	74	69	83	63	51	34	782
Morn grain	62	55	72	70	78	75	78	75	62	62	60	62	811
Even grain.	98	117	141	133	155	150	155	150	124	124	120	124	1,591

Table No. 8b—No. 43 Soy Bean Meal Pen.

MONTH.	Nov. 1913	Dec.	Jan. 1914	Feb.	Mch	Apr.	May	June	July	Aug	Sept	Oct.	Total.
Eggs laid	35	86	391	390	357	284	216	176	96	158	36	53	2,278
Mash.	33	58	111	75	41	54	58	49	50	67	43	51	690
Morn. grain	62	62	87	84	78	45	47	45	47	47	45	62	701
Even. grain.	62	93	118	112	155	90	93	90	93	93	90	124	1,306

Table No. 8c—No. 46 Gluten Meal Pen.

MONTH.	Nov. 1913.	Dec.	Jan. 1914	Feb.	Mch.	Apr	May	June	July	Aug.	Sept.	Oct.	Total.
Eggs laid. . .	50	92	200	303	359	185	158	59	70	272	87	68	1,903
Mash. .	37	82	81	55	62	64	57	29	75	75	72	66	755
Morn. grain. .	62	62	62	56	55	60	62	60	62	62	60	62	787
Even. grain..	104	124	124	112	147	90	93	90	93	93	90	109	1,269

Table No. 8d—No. 47 Oil Meal Pen.

MONTH.	Nov 1913	Dec	Jan 1914	Feb	Mch	Apr	May	June	July	Aug	Sept.	Oct.	Total
Eggs laid.	11	47	144	149	308	150	154	78	29	93	27		1,200
Mash.	29	63	58	39	40	55	41	25	28	26	21	42	467
Morn. grain.	62	62	62	73	60	60	62	60	62	62	60	39	724
Even. grain.	109	109	109	129	155	90	93	90	93	109	105	109	1,280

Table No. 8e—No. 48 Cottonseed Meal Pen.

MONTH	Nov. 1913	Dec	Jan 1914	Feb	Mch	Apr	May	June	July	Aug	Sept.	Oct	Total
Eggs laid.	85	206	226	210	374	173	220	73	29	78	37	4	1,715
Mash.	40	68	88	74	49	53	48	25	37	23	38	30	573
Morn. grain	62	62	69	43	58	45	47	45	47	62	60	39	639
Even. grain	111	124	140	125	147	75	78	75	78	109	105	109	1,279

During the first year the mortality has been high in the pens receiving the oil meal and the cotton seed meal. A number of the birds have apparently broken down under the strain of the highly concentrated rations.

Source of Succulence.

During the winter months when fowls are kept for the greater part of the time closely confined within the house there is great danger that the birds will not receive as much succulent, juicy, food—material as their bodies demand. Especially has it been found necessary to furnish the laying hens with a considerable amount of succulent, watery food as eggs, their product, contain a very high percentage of water, and as the normal and natural operations of all the organs within the body depend very largely upon the amount of watery food which they take into their bodies. The problem of furnishing succulent material of this kind has been a more or less serious one on many New Jersey plants, as it is not always an easy proposition to furnish material of this kind during the winter months. There are several possible sources of succulence, the exact value of which has never before been carefully worked out. Because of this fast an experiment was started on January 1st of this year to try out some of the common and easily available succulent foods. White Leghorn pullets were used, fifty uniform females being placed in each of the five small pens. All conditions, including grain and mash fed, were identical; the only varying factor being the source of succulence afforded. In the first pen Succulenta tablets, a commercial product, were used. These tablets were given in the drinking water of the fowls according to the directions furnished by the manufacturers. In the second pen dried beet pulp was used as a source of succulence. It was soaked for an hour in luke-warm water before feeding. In the third pen mangel

beets, grown on the Station plant and stored in a cellar, were used. In the fourth pen sprouted oats were used as green food, and in the fifth pen the birds were not allowed succulence of any kind.

The following table, No. 9, gives the egg production of the pens in this experiment.

Table No. 9.—Source of Succulence

PEN.	Nov. 1913	Dec.	Jan. 1914	Feb	Mch.	Apr.	May	June	July	Aug.	Sept.	Oct.	Total
Succulenta. . .	178	219	378	467	642	760	639	461	251	198	190	57	4,432
Dr'd beet pulp	200	382	367	508	776	749	607	397	236	247	156	45	4,670
Mangel beets	140	326	394	592	869	792	750	612	219	359	263	31	5,347
None.	157	192	370	457	672	728	631	409	118	217	182	85	4,239
Sprouted oats.	137	376	427	542	744	779	685	431	256	375	260	85	5,517

Definite conclusions have not been formulated nor will they be until the close of the third laying year of the birds used in this work.

Housing.

The observations to secure data pertaining to moisture variation, temperature variation, cost of construction, etc., as applied to Poultry House Construction, which have been under way for three years, have been discontinued. It is believed that we have all the data necessary, pertaining to these variations. Our recent efforts have been concerned in the application of these details to the practical construction of poultry houses. The New Jersey Multiple Unit House as recommended in the last annual report has been received with a great deal of favor, and has become very popular throughout the State. During the past year we have attempted further to standardize the house question and to devolve standard sizes and types of houses for all size flocks. The following tables show these dimensions as applied to these different houses. (Table No. 9½.) The general arrangement of nests, dropping hoards perches, and glass and muslin openings should conform to the detailed recommendation made for the New Jersey Multiple Unit Laying House as given on pages 259 to 264 in the report of this Department for the year 1913. It is expected that a bulletin will be published soon covering the scientific data accumulated from the past studies in poultry house construction together with the practical application of the information thus gained.

Table No. 9½.—Standard Multiple Unit Houses.

Size.	Sq. ft. Floor.	Capacity.	Height Front.	Back.
6x8	48	10 hens	7 ft.	5 ft.
8x8	64	20 hens	7 ft.	5 ft.
10x10	100	25 hens	7 ft.	5 ft.
12x12	144	40 hens	8 ft.	5 ft.
14x14	196	50 hens	8 ft.	5 ft.
16x16	236	60 hens	8.5 ft.	5 ft.
18x18	324	80 hens	8.5 ft.	5 ft.
20x20	400	100 hens	9 ft.	5 ft.

Each house to have one square foot of glass window to every twenty square feet of floor space.

Each house to have one square foot of muslin opening to every ten square foot of floor space.

Observations during the past year have convinced us of the need of a standard duck house covering New Jersey conditions, and of a double pen breeding house to be used for breeding flocks on general farms. The following paragraphs give detailed recommendations pertaining to such houses.

New Jersey Multiple Unit Duck House.

During the past year there have been numerous requests for the plans and specifications of a practical and economical duck house. Because of this, the Department of Poultry Husbandry has designed a duck house which is reasonable in price and convenient in practical management. It is of the multiple unit style, so planned that as many units may be added as may be found necessary for any given flock. The house is of the shed roof type, each pen being 16 feet deep by 10 feet in width. A four foot alley-way runs the entire length of the rear part of the house. There is six feet of head room at the rear of the house and eight feet at the front, giving the roof enough pitch to carry off all rain and melting snow. The front of the house is one of the most important parts and its design has received particular attention. No glass is used. Practically the entire front of the house will be open, with the exception of the lower two and one-half feet. An eighteen inch projection is to be built from the front edge of the roof at an angle of 66 degrees with the front face of the building. The purpose of this projection will be to prevent the rain and snow from blowing directly into the house, while at the same time permitting the entrance of a liberal amount of sunlight into the house. Muslin curtains may be hinged to the inner side of these open fronts, to be lowered only during severe storms in the winter and spring. The divisions between pens will be three feet high and constructed of matched lumber.

The following list of material will be necessary for the construction of this house.

2 inch x 4 inch Hemlock material	8 feet lengths	21	pieces
" " " " "	10 " "	17	"
" " " " "	12 " "	23	"
" " " " "	14 " "	5	"
2 inch x 6 inch " "	10 " "	2	"
1 inch x 3 inch White Pines "	12 " "	6	"
" " " " " "	10 " "	6	"

6 inch White t. and g., 15— square feet.

Novelty siding, 324 square feet, planed lumber, 6 inch stuff, 75 square feet; roofers, 365 square feet roofing paper, 365 square feet nails hinges, three pairs cement and cinders and sand for foundation

The above list is to erect one feed room and one section of the *Multiple Unit Duck House.*

To erect additional duck pens will necessitate the list below for each pen.

2 inch x 4 inch	Hemlock material 8 feet lengths.		6 pieces
" " "	" " 10 " "		18 "
" " "	" " 12 " "		1 piece
	Novelty siding.	100 sq. ft.	
	Planed lumber 6 inch stuff	25 sq. ft	
1 inch x 3 inch	White Pine, 12 feet lengths		6 pieces
	Roofers	175 sq. ft.	
	Roofing paper	175 sq. ft	
	Nails and one pair hinges Cement, cinders and sand for foundation.		

From the average price of the materials in the above list, it has been estimated that the feed room and one section will cost approximately $75.00 Each additional pen will add $30.00 to the cost of the building It is considered an economical and convenient type to use for the housing of ducks It is simple in design and can be quickly cleansed, a feature very desirable in a house used for ducks It provides for a maximum supply of sunshine and an abundance of fresh air, two factors which should be included in every poultry house. Blue prints of this building will be sent to residents of New Jersey upon request.

New Jersey Two-pen Breeding House.

The New Jersey Two-Pen Breeding House is a building suitable for various conditions. It can be used for a back yard flock in the city, on the larger town lot, or as a colony house upon almost any plant. It can also be used for two pens of breeding birds upon any poultry plant. The house contains two 6′ x 10′ pens, and will have a capacity of fifteen birds in each pen. The cost of the lumber for the house will be about $25.00. There will be a little extra for hardware and roofing paper.

The outside dimensions over all are 10′ x 12′ the sills are to be 4″ x 4″, and the house is to be placed upon a concrete foundation. The shed roof type of construction is used with 7′ 6″ studding in front, and 5′ studding in the rear. All the studding and rafters are 2″ x 4″ hemlock. The plates are single and are made of 2″ x 4″ material.

All the outside walls and roof are single-boarded. The roof and rear wall should be covered with some good roofing paper. The muslin curtains in the front wall are hinged at the top and can be opened or closed as desired. The dropping boards and perches are placed against the rear wall and the nests are fastened upon the partition dividing the pens. The Connecticut type trap nest is used so that a complete record of each pen may be kept. This dividing partition will be built of boards so as to prevent draughts. Upon the opposite wall will be placed "broody" coops with slat bottoms.

There will be an elevated platform in the front of the house which will provide room for the water pan. There will also be a door into

each pen, and a swinging door between the pens. There will be a half window in each outside door, this being the only glass in the house. The window in front will be 4′ x 4′ covered with wire, and also having a muslin curtain to use in cold weather.

The following is a list of material necessary:

All the framing material hemlock or yellow pine.

Sills. .	2 pieces	4 x 4 inches	10 feet long	
	2 "	" "	12 " "	
Plates	4 "	2 x 4 "	12 " "	
Studding	7 "	" "	12 " "	
	3 "	" "	14 " "	
	5 "	" "	16 " "	
Rafters	8 "	" "	12 " "	

Boards for sides and ends, 250 square feet. Novelty siding.
Roof—200 square feet. Yellow Pine, 50 extra for dropping boards, etc.
Hardware—8 No. 10 penny nails, 5 No. 20 penny nails, 2 pairs T hinges, 1 pair spring hinges, 5 pairs small hinges, 2 door latches, 2 catches for the curtains, 1½ rolls of roofing paper.

Breeding.

The research projects in poultry breeding are along two distinct lines, namely, a study of the inheritance of egg production and a study of the mode of inheritance of the color factor. The experiment in breeding for fecundity, which was described and briefly outlined in pages 249 to 253 of the annual report of this Department for the year 1913, has been continued. While no individuals have been bred producing a greater number of eggs than 246, which was the production of Hen No. 531, yet we have been able to secure a large number of relatively high-producing individuals. The policy of this Department in this work has been to breed a considerable number of pedigree cockerels from strong, vigorous, healthy birds, and to disseminate these cockerels about the State at a nominal cost. Approximately 300 birds have been so distributed during the past year at prices ranging from $2.50 to $5 per bird. This amount covered the cost of pedigreeing, trap nesting, banding, etc. It is planned to follow up these birds, and to study the effect of their introduction into commercial flocks in the State. It is recommended that the poultrymen using these birds mate them to a few of their best hens, and from this special mating breed their cockerels for use next year in their large breeding flocks. As soon as the breeding pens on the new poultry plant become available this work will be materially enlarged and developed along more definite research lines.

Inheritance Studies With Poultry.

The cross breeding project which has been under way for the past three years has produced in the F. 2 generation characteristic combinations which will admit of a great amount of study and original investi-

gation. The original parents and the characterics possessed by the F. 1 generation have been outlined on page 253 to 257 in the report of this Department for the year 1913. The cross breeding work has been carried on with reciprocal crosses of Black Langshan and White Leghorns. In this investigation of the inheritance of plumage color, shank color, eye color and beais color it has been assumed that the Black Langshan is essentially a white bird, which, however, possesses a black pigment or coloration, superimposed upon the white. That is, the eye is essentially a bay, containing black pigmentation superimposed. The beak is essentially white, and so with the shanks. In the pure bred Langshans black pigmentation is then assumed to be superimposed upon the white. In the inheritance of this superimposed pigment various amounts of it appear, less and less being exhibited as the pigment factor becomes diluted, due to the admittance of the White Leghorn characteristics. With this hypothesis as a working basis we may analyze the apparent sex limitation in the mode of inheritance of this superimposed pigmentation as follows: In the F. 1 generation a superimposed pigmentation appears to be sex limiting in this mode of inheritance only when the male parent possesses said pigment. The mode of inheritance in F. 2 seems to bear out this assumption, and furthermore individuals have been produced which show, without a doubt, that Leghorns carry a factor for barring. The following general conclusions have been drawn from the evidence accumulated after a study of two geneations from the original cross:

1. The Black Langshan is essentially a white bird with white plumage, white shanks, white beak and a bay eye. Superimposed upon this is a black pigment. This superimposed black pigment is sex limiting in this mode of inheritance only when the male bird possesses this black pigmentation; in which case, so far as this inheritance in the first generation is concerned, it behaves similar to a dominant character.

2. White Leghorns carry, without a doubt, a factor for barring. Results tend to point to the fact that the factor which inhibits the appearance of the barring, (if such a factor is used to explain the non-appearance of the barring) varies in intensity in different individuals, and may vary in the same individual at different times. The cause for this at present is undetermined.

Before final conclusions are drawn from this cross breeding work it is the plan to check up the observations with other reciprocal crosses, and to do this work with a sufficient number of individuals to avoid, in so far as possible, the danger of drawing erroneous conclusions through insufficient progeny. With the completion of the new poultry farm and an adequate number of breeding pens, this work will be

It is absolutely essential that growing birds on the ranges, and particularly the pullets that are to be the future layers and breeders, should be afforded abundant shade and fresh, green food during the hot summer days. *Such environments must be provided as will enhance their growth* in every possible way, thus keeping their development continuous and without set-back throughout the summer season.

among the most detailed and carefully executed of any of our research projects.

Observation Projects.

I shall mention in the following paragraphs a few observations, made during the past year which have a direct practical bearing on commercial poultry management. These results have been and will be more fully described from time to time in our monthly "Hints to Poultrymen." Observations have been made during the past year as to the necessity of shade on the range for growing chicks. This necessity, especially during the summer months, has previously been determined. The best method of providing same is, then, the vital question. During the past summer three ranges of one acre in extent were used, and Leghorn pullets were placed on each. One range contained peach trees, another was seeded to field corn, and the other range was sown early in the spring to buckwheat. The efficiency from the standpoint of providing ideal range conditions was in the order named. The acre of peach trees provided constant shade, admitted of a circulation of air, and was by far the coolest and most desirable. The birds on this range made the best growth under similar conditions, in so far as management was concerned. Considerable damage was done to the peach trees from the standpoint of peach production, owing to the fact that the pullets, as soon as they got to be three months of age, began to roost in the branches, breaking them down and injuring the head of the tree. As soon as the fruit began to ripen a great amount of damage would have been done if the pullets had not been removed immediately, and very young birds put on the range in their place. So far as poultry keeping and fruit growing is concerned, from the standpoint of the poultry flock, the peach orchard furnished ideal environment for growth during the summer. From the standpoint of the peach orchard, the presence of the birds would have a materially detrimental result, especially if birds of more than three months of age were kept on it. This detrimental result would be the injury to the tree and the destruction of the fruit at the time of ripening.

The second range, which was planted to corn, provided adequate shade and ideal range conditions. One exception, however, was noted. On account of the thickness of the corn the air, especially the northwest winds, which are cooling in the summer, could not circulate through it freely. This resulted in a higher temperature in the corn range than in the orchard; nor was the shade quite so dense and hence

as cooling as that given off by the peach tree foliage. On the other hand the birds caused no injury to the corn, and a heavy yield was received, the stalks being shredded and used for litter.

The buckwheat range was seeded to heavy buckwheat. The buckwheat was allowed to attain a height of eight inches before the birds were placed on it. It grew to a height of approximately two feet and the growth was very luxuriant. Owing to the density and low growth the temperature conditions were not the coolest. After the birds had reached maturity the buckwheat was mowed and after curing it was placed in the laying houses for litter. As a general observation of the conditions on these three ranges it may be said that it would doubtless be better to plant the peach trees on a special area devoted exclusively to orchard conditions, and to use corn for shade on the poultry range. The birds caused no injury to the trees until they attained the age of three months. It may be desirable, therefore, to use peach orchards for early range and the corn field for the late summer and early fall periods.

Hatchability of Eggs as Affected by Weather.

A great deal has been said in the past about the injurious effect of frozen combs and extremely cold weather in the winter upon breeding birds. The past spring, owing to the blizzard which took place in March, afforded an excellent opportuniry to determine the true injury from such causes. The months of January and early February were typical winter months, cold, but moderately dry, with no severe storms. Breeding stock could be easily kept in a healthy, normal vigorous condition and eggs set at that season of the year resulted in normal hatches and normal broods. During the blizzard, which struck the Atlantic coast and the New England States in March, the humidity was very high and the temperature very low. This resulted throughout this section in a great many frozen combs and wattles, and in a general lowering of vitality in all breeding flocks, with both males and females. Eggs saved for hatching during that period were found, upon incubating, to be very low in fertility and what fertile eggs were secured were found to contain germs which were weak. Poor hatches, chicks with low vitality and a high death rate at an early period add the natural sequence of these conditions. The result of this blizzard was an abnormal number of April hatched pullets which, it is generally recognized are the best pullets for late fall and winter egg production. The poultryman who succeeds in hatching a relatively large

number of early pullets can well congratulate himself, for he is thereby assured of a good supply of fall layers, whereas the man who depends entirely upon April hatched birds suffers a serious shortage if conditions in April are not suitable for a normal production.

The conclusions are, therefore, two in number;

1. It is a safe and sane practice to hatch at least one-third of the number of pullets which will be needed for egg production, before the last of February.

2. Eggs for hatching should naturally be saved from breeding flocks in which the individuals are not suffering from frozen combs, wattles or a general lowering of vitality, due to abnormal weather conditions.

The Breeding Flock and the Breeding Male.

Observations are under way, which are planned to continue for at least two years, to determine the relation which exists between vigor, age and health of the breeding flock and the hatchability of eggs which are produced. These observations to date point to the following conclusions:

1. Only eggs should be saved for hatching from hens which have reached maturity, or expressed in another way, for hens which have been through at least one complete moult

2. Eggs should be saved for hatching only from mature birds that have not been excessively forced for heavy egg production during the previous winter. It is apparent that eggs laid by such birds do not possess the strength and the density of albumen which is essential for the best vigor in the resulting chick.

3. Eggs should be saved only from breeding flocks which are vigorous and healthy in every respect.

Hatching Dates.

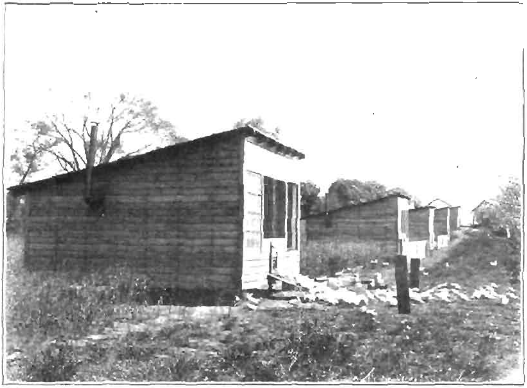
A study of the egg production from pullets hatched at different seasons which has been in progress for the past four years, has been continued. It has become more apparent every year that early hatching *is the most profitable, not only from the standpoint of number of eggs* produced in the early fall when the price is high, but also from the standpoint of the increased assurance which the poultryman has against loss through poor hatches at a later date. It may be observed also that early hatched birds will admit of a disposition of the surplus males and culled pullets at a handsome price for cockerels before the early summer price fluctuations take place. Another result will be that these early hatched pullets will make strong, admirable breeders for the reason that they have gone through a late moult, and will essentially be yearling hens in so far as quantity and character of egg production is concerned.

A Record of Fall Hatched Pullets.

One of the most practical problems which every poultry raiser has to consider seriously is that of the time of year at which to hatch his

chicks. The advisability of hatching Leghorns early in the spring has, in many places, been questioned. At the Station plant during the past year simple observations have been made with two pens. The first consisted of about fifty Single Comb White Leghorn females which were hatched in August of the year 1913. The second pen consisted of about two hundred Single Comb White Leghorn females which were hatched in February 1914. Careful egg records have been kept and are being kept of both pens. Up to the present time the results are of enough interest to merit a short description in this report. The August hatched pullets did not begin laying until February. They were somewhat slow in developing and did not reach maturity until the cold weather of late fall and early winter had set in. The production from February until the last of October was at no time phenomenal, reaching its height in April when a percentage of production of forty-five was reached. March and May were both fair months, the production running about thirty-five to forty per cent. The results obtained in this pen indicate that there is no argument for late fall hatched pullets. Every poultryman who is interested in egg production desires to have his pullets laying during the winter months when eggs are at the highest prices. The spring months, March, April and May are the seasons of naturally high prices. Birds hatched late in the season did not have time to mature before winter set in, and consequently were not fitted for egg production until along in the spring. The weather conditions in the summer when the chicks were small was also unfavorable, as the heat was intense and the chicks did not get as good a start as did the chicks hatched in the spring.

In February, 1914, the Short Course students hatched about 700 Leghorn chick, from which were selected about three hundred pullets. These chicks were brooded under ideal conditions in a long brooder house and grew rapidly, being ready to put out on the range when the pleasant days of spring arrived. They were reared during the spring and early summer on a peach orchard range. The flock was culled during the first week in August and two hundred of these pullets were placed in the New Jersey Multiple Unit Laying House. They started to lay early in August; many of them were laying when they were placed in the house. During the months of August and September the production ran as high as 50 per cent. and the profit above feed was, in round numbers, $62.00. During the month of October the production was about the same, falling off just a little during the last week when some of the birds began to moult. The objection has



These colony houses, twelve feet by fourteen feet, were used as brooder houses, each being equipped with a coal-burning brooder. The open front furnished abundant fresh air, and the windows allowed plenty of light early in the spring when it was necessary to keep the muslin curtain lowered. The roominess of these houses aided in making them very satisfactory for the purpose for which they were used.

been made to the early hatching of Leghorns that they would invariably begin laying early in the season and then go into a fall moult. This flock, however, is not, up to the present time, (the 22nd of November) showing any signs of going into a complete moult. Only about one-sixth of the birds are moulting. From the behavior of this pen the question might be raised as to whether or not more profit can be realized from a good production during August, September and October, even if it were followed by a more or less complete moult in late October and November. Birds hatched late in the spring and summer do not undergo this moult, but on the other hand, they do not begin laying until October or November. Further observations will be made along the same line before any general conclusions can be reached.

Observations With Brooder Stoves.

One of the most modern evolutions in the poultry business is the large flock brooder stoves that have a capacity of from 500 to 1,200 chicks. The Poultry Department has, during the past year, investigated five different types of brooder stoves, ranging in capacity from 300 to 1,200 chicks. It is the purpose here simply to state a few definite conclusions which have been arrived at after the completion of this observation:

1. The large flock brooders, having a capacity of approximately 1000 chicks, if suitably located and operated, may provide satisfactory brooding conditions for the first five weeks. It is our experience that regardless of the room which the chicks have they should be divided into smaller flocks at five weeks of age. The crowded conditions which are bound to occur when a large number are kept together produce an anaemic condition, making the birds susceptible to tuberculosis and other physiological disorders which would be avoided if more room is given them.

2. It is practically impossible to maintain a sufficiently even temperature in the large metal brooder stoves when the warm weather of May is experienced. We are satisfied that one of the greatest faults in brooding is too high a hover temperature, which is especially apparent in a metal brooder stove where coal is used for fuel and where it is impossible to elevate or cool off the hover.

3. The most efficient forms of brooder stove which we have yet used are those having a capacity of approximately 250 to 300 chicks. They have a relatively small fire pot, but considerable radiating surface. They are equipped with a hover which is independent of the stove, and so arranged that it can be raised or lowered in order properly to regulate temperature.

A relatively cool hover that has a constant temperature and not more than 300 chicks in a flock has proven far superior to the large, intensive, fixed metal hovers.

Diseases.

The work in disease investigation and diagnosis has been under the direct charge of Mr. Willard C. Thompson, and has been productive of some very interesting and valuable observations as to prevalence of poultry diseases, including their seasonable occurrence, possible losses under varying conditions and simple methods of control. The following discussion presents a very vital matter to the average farm poultryman, namely, the loss which is so common during the hot summer months through birds dying from apparent poisoning. The definite cause had not until this time been definitely determined.

Summer Sickness.

During the past summer members of this Department were called upon to visit several poultry farms in the State where birds had been dying in large numbers from an unknown cause. After most careful examination of the conditions in all these places the conclusion was reached that the trouble was due to the eating of carrion flesh. Semi-decayed flesh which has undergone putrefaction is an extremely dangerous material for birds to have access to. The eating of this material causes a more or less complete prostration or apparent paralysis. In all cases this symptoms appeared to be those of ptomaine poisoning. The birds were affected suddenly, losing control of the muscles of the neck and feet, which resulted in the throwing of the head forward in a lifeless manner upon the ground, and the absolute lack of control of the legs. In many cases there was a severe diarrhoea exhibited, and the birds appeared to be in great pain. The duration of the trouble depended upon the amount of the semi-decayed flesh that had been eaten. Upon searching the premises some source of this material was, in nearly every case, found. In many places birds had been buried, but not sufficiently deep, so that the other birds in scratching had unearthed the carcasses and picked at them. In other places dogs had unearthed material of this kind and carried it from place to place. Particularly was this thought to be the source of the trouble in the poultry yards in the smaller towns, or suburbs. There were some thirty-five letters received during the summer reporting the same conditions as were found on the farms described above. This trouble seemed to be so wide-spread and so important to control that a series of suggestions were formulated and sent to all parties concerned. They were as follows:

1. Decaying flesh will apparently cause a sort of ptomaine poisoning which will result fatally in the majority of cases.

2. The dead carcasses of birds should be completely destroyed, preferably burned.

3. In case it is not possible to burn the carcasses they should be buried at least three feet deep. This will prevent their being unearthed by fowls in scratching, or by dogs and other small animals.

4. Do not bury carcasses of any kind in the range over which poultry run during the summer.

5. Do not bury dead carcasses in a place in which stagnant water stands at any time of the year.

6. Do not bury any dead carcasses near a stream of water.

7. When birds are seen to exhibit symptoms of poisoning immediate search should be made for the possible source.

8. Remove all affected birds from the flock. Treat those which are not seriously affected with a liberal dose of epsom salts. Allow a teaspoonful to two birds. Dissolve this in a little warm water and pour down the throats of the birds. This may result in carrying out of the body the poison material which has been eaten. If caught in the early stages it may be possible to bring the birds back to normal again.

9. Dead flesh decays rapidly during the warm weather.

10. Accumulation of maggots has caused the same trouble; therefore, do not allow dead carcasses to remain about the place where the flies may have access to them.

New Lines of Experimental Work.

The Poultry Department has planned several new lines of experimental work for the coming year. There are many questions in regard to the various phases of the poultry industry that need careful work and more extended observation. Experimental and research work has a very definite value to the people of the State. Often times it is thought that work of this kind has no practical value. This same work, however, enables the Experiment Station to speak with authority on subjects that upon which it has worked. It is necessary for someone to go to the bottom of questions and problems in an effort to find out the why and wherefore. It is not practicable for the poultry raiser to do this because of the vast amount of time and expense needed in such work. Unless this is done it is impossible to give definite and accurate advice upon problems affecting the feeding, breeding and housing of poultry. The feeding of sour skim-milk is to form the basis of extensive work during the coming year. Combined with this work will be feeding experiments with several different kinds of milk products. It is believed that many poultrymen, particularly suburbanites, cannot economically obtain sour skim-milk. They do, however, wish to use some form of milk, and it is these people who are raising the question as to the value of certain commercial products, such as milk albumen and milk powder. This work will be conducted with both Leghorns and Plymouth Rocks. Sour skim-milk will be used through out the coming year in several of the laying pens at the Station plant in

an effort to establish its value as a supplemental food for laying fowls. Another line of work will deal with the efficiency of certain fattening rations. In the past great attention has been given experimental work regarding factors pertaining to egg production. It is believed that careful attention should be given to other phases of the poultry industry as well. Extended observations upon the factors influencing the moulting of fowls will also be made. A new laboratory equipment will make possible more extensive work along the line of poultry disease investigations. The correspondence of the Department during the past year has indicated the great need of work along this line. Poultry disease is one of the most important limiting factors in poultry production. There are many diseases, causing enormous losses annually to the poultrymen in the State, which are not understood. The great problem will be to find the causes of these troubles, and thus be enabled to work out practical methods of prevention.

Extension Work.

The extension efforts of this Department are becoming more and more diversified, and as the increased interest in the poultry about the State has been felt, a greater demand has been apparent for increased efforts along this line. During the past year Mr. A. L. Clark, Poultry Specialist in Extension work has had direct charge of many of the extension projects. For a detailed account of the Boys' and Girls' Poultry Club work, and also for detailed conclusions as to the amount, cost and duration of egg production under farm conditions, see annual report of the Extension Department.

The following factors pertaining to the General Extension in Poultry Husbandry for the past year will doubtless be of interest. The publications of the Department have been used extensively in extension work through the answering of correspondence and in the supplying of literature upon requests. For details as to publications see page 8.

Several new live poultry associations have been formed. The following is a list of the local Poultry Associations in New Jersey together with the address of their executive officers:

Bergen County Poultry Association. John M. Meyers, Westwood, N. J., R. D. No. 2.
Blairstown Poultry Association. A. B. Craig, Blairstown, N. J.
Burlington Co., Poultry Association, G. Greenfield, 235 Conover St., Burlington, N. J.
Coyettsville Poultry Association, Walter P. Taylor, Cold Springs, N. J.
Dover Poultry Association, Carroll H. Hoagland, Ledgewood, N. J.
Essex County Poultry Association, Robert De Camp, Livingston, N. J.
Glen Rock Poultry Association, J. L. Pilkington, Ridgewood, N. J.
Gloucester County Poultry Association, Wm. W. Rehr, Woodbury, N. J.
Manasquan Poultry Association, T. J. Woodfield, Manasquan, N. J.
Greater Newark Poultry Association, James L. Adams, 101 Union Ave., Irvington, N. J.
Hudson County Poultry Association, H. W. Gaddis, 28 Cottage St. Bayonne, N. J.

Middlesex County Poultry Association, F. S. Zimmerman, New Brunswick, N. J.
Monmouth County Poultry Association, Frank H. Hodges, Red Bank, N. J.
Morristown Poultry Association, Stuart R. Whitenack, 3 High St., Morristown, N. J.
N. J. Association for Poultry Improvement, W. J. Trembath, 17 Chatham St., Plainfield, N. J.
North Jersey Poultry Association, H. J. Woodward, Newton, N. J.
N. J. Poultry, Pigeon and Pet Stock Association, A. A. Hunter, Merchantville, N. J.
Ocean County Poultry Association, Owen B. Shutes, Toms River, N. J.
Passaic Poultry, Pigeon and Pet Stock Association, Wm. Huntermark, 157 Main Avenue, Passaic. N. J.
Paterson, Poultry, Pigeon and Pet Stock Association, Dr. Gilbert Johnston, 210 Market St., Paterson, N. J.
Poultry Growers' Association of Hammonton. Thos. J. Kelly, Hammonton, N. J.
Port Norris Poultry Association, H. C. Barraclough, Port Norris, N. J.
Salem County Poultry Association, C. W. Thompson, Salem, N. J.
Somerset County Poultry Association, J. Roy, Somerville, N. J., R. F. D. No. 3.
Trenton Poultry Association, E. S. Stryker, Trenton, N. J., R. F. D. No. 2.
Union County Poultry Association, C. Harry Scherf, Elizabeth, N. J.
Vineland Poultry Association, H. A. Pender, Vineland, N. J., R. D. No. 4.
Washington Poultry Association, Wm. H. Cyphers, Washington, N. J.
South Jersey Poultry Association, Chas. H. Maier, Bridgeton, N. J.
Easton Poultry Association, W. F. Bast, Phillipsburg, N. J.
Florham Park Poultry Association, Carnot M. Ward, Florham Park, N. J.
Lakewood Poultry Association, C. W. Stearns, Lakewood, N. J.

During the past year these educational associations have formed among themselves a Federation, the primary object being co-operative efforts. Among the activities of the Federation are the following:

1. *The securing of suitable Legislation for the promotion and protection* **of the Poultry Industry in the State of New Jersey.**

2. **The organization of suitable co-operative agencies for the selling of eggs and poultry products.**

3. **The organization of suitable agencies for the co-operative purchasing of feeds, poultry supplies and appliances.**

The following is a detailed description of a scheme which has been worked out for the co-operative selling of eggs. This effort has just been put into working order, and the future will determine the opportunity for successful co-operation along this line.

The New Jersey Plan for Co-operative Egg Marketing.

At the first meeting of this Federation, which was attended by delegates from most of the thirty-five poultry associations in the State, held in the fall of 1913, a suggestion was made, that with this large organization, certain definite steps could be taken toward placing the poultry industry on a more profitable and permanent footing in the State. Better marketing facilities was mentioned as one subject worthy of consideration. Accordingly a committee was appointed and made its report at the winter meeting, which is embodied in the April "Hints to Poultrymen," published by the Poultry Department of the State Experiment Station. The committee was instructed to perfect its plans so that active operations could be begun this summer. The work has been unavoidably delayed, but the committee has exerted itself in perfecting the details.

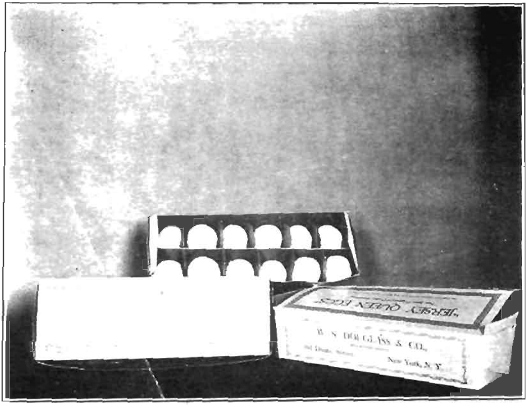
Purpose and Scope.

We should remember that although our State is known as a poultry State, we supply New York City with only one or two per cent. of its total receipts. On the other hand, our eggs are in a small class, and if only first-class, fresh-laid eggs are considered New Jersey is a large factor. Especially is this true of white-shelled eggs. The purpose of this plan and the need of the average poultry raiser in the State, as the committee understands conditions, is *a more efficient method of supplying particular people in large cities with the finest quality eggs which can be produced.* This includes the elimination of loss to a large degree from improper packing methods, little or no grading and wholly unsatisfactory systems of distribution. The demand in New York City, the greatest egg market in the world, is for food products of superior quality and appearance. We can furnish the best grade of eggs at less cost and greater profit to ourselves than can poultry raisers of any other district. We can, but in many cases we do not. The average producer is as *ignorant of market conditions* as is the average market man in a large city of any line of farming. The persons who demand this high class of products not only ask for freshness, quality and appearance. They desire to feel absolutely sure that they can depend always upon the uniformly high grade. They want to feel sure that the supply is of sufficient volume to furnish them at all times. If any one of these factors is lacking this class of trade is diverted. The committee believes that only through co-operative efforts of many careful producers can this trade be permanently secured and held. The task at hand is to get it established.

Outline of Plan.

The plan includes the selection of reliable, experienced dealers in the large cities to act as our agents. We are starting with one in New York City. We are not starting under a handicap by setting a new store with inexperienced operators, as has often been tried. We recognize that the *selling end of the business is intricate,* that there are many conditions which exert a vital influence upon the success or failure of such an enterprise with which only an experienced man can successfully deal.

All members of local associations belonging to the Federation are privileged to send their eggs to this agent. They will be carefully graded and packed by the agent, who will carry on the business of selling in his own way, but under the supervision and with the full co-



The selling of market eggs of highest quality under a well-known trade-name has long been acknowledged as a good business practice. In order for any such marketing scheme to become of important value to poultrymen, *it is necessary first of all to produce only highest quality eggs, sterile* eggs for the greater part of the season, and always fresh, clean eggs.

operation of the Federation. Returns will be made on the day of sale and all possible energy will be used to move the eggs rapidly. Arrangements can be made by individual shippers to have a part of their eggs stored during seasons of heavy production, and consequent low prices. The storing facilities will be of the best and our agent is well acquainted with this end of the business.

Requirements to Ship.

The only requirements made of these who desire to take advantage or who wish to support this project are: first, that they must be *members in good standing* of a society belonging to the Federation of Poultry Associations; and, second, that they will so manage and care for their flock that only *eggs of high quality and flavor* will be produced. The services of the Poultry Department of the State Experiment Station are available for suggestions and methods of practice.

The secretary of any local association can secure through the committee "shippers' numbers." Shipping tags will be forwarded to the shippers to use on each shipment. This tag, marked with a shipper's number, insures its recognition by the agent.

Small eggs, or those of poor shape, etc., will be disposed of by the agent through suitable channels, but high grade goods are going to receive special attention.

Upon complaint to the committee by the agent a shipper's number can be cancelled, if upon investigation such action seems to be to the best interest of the association.

Duties of the Agent.

The agent will receive all eggs from shippers bearing an authorized number. It is urged that where eggs are shipped by express they be shipped collect. This sometimes facilitates the collection of damage charges, etc.

Each shipment will be graded and candled separately and the shipper given credit for the following grades: *first whites* and *first browns* will be large, clean eggs of the highest quality. They must weigh 24 ounces per dozen. The whites must have chalk-white shells, and any tinting or color will place them in the class of browns. In warm weather, eggs to come in these classes must not be over a few days old. It will be found that conditions under which eggs are kept will have more influence in determining the quality than mere number of days. Seconds will include all small, shrunken and dirty eggs which may be

received. Many times large numbers of small eggs are produced on the best farms from flocks of pullets. Good markets can be found for these in the large cities. *Shrunken eggs* are those in which the moisture has evaporated more or less. This condition is often found in eggs held for several days or more. It should be guarded against. When a small shipper is securing only a few eggs each day it may become impossible to fill a case or even a half a case often enough to prevent this condition. This matter should be discussed by the local association with the idea that two or more individuals combine and ship together. In this way frequent shipments can he made, which is the only way in warm weather to insure the best results. *Checks* is a market term applied to all eggs cracked or broken.

Complete accounts must be kept by the agent, which will be open to the Association's committee at all times. These accounts must include each sale, the purchaser's name, price paid, etc. The agent will endeavor to develop a large trade for our best eggs packed in one-dozen cartons. Our New York agent is to put a special man on this work. *All eggs not sold in cartons will be sold in standard thirty-dozen cases.*

Distributing Packages.

The association will supply the agent with suitable cartons and with labels to place upon the sides of cases containing our eggs. On the cartons and labels will be printed the statement that these eggs are produced on poultry plants managed along the most approved lines, and that every effort has been made to insure the high quality of the products; that the eggs are not only produced, but are graded, packed, sold and guaranteed by this association of several thousand actual producers. A small slip will be enclosed in all packages covering in some detail the purposes and aims of the association. Of late years there has been much agitation concerning more direct dealing between producers and consumers. The time is now ripe to inaugurate such a plan as this. All eggs sold will go out under definite trade names (probably copyrighted), and a buyer can easily know how and where to secure similar goods again.

Building Up a Trade.

This will largely be in the hands of the agent. However, every member should consider himself or herself responsible for advertising our goods. We are going into this project at the right season. Receipts will be small to begin with, but should increase to large quantities next spring. Our best eggs packed in cartons should find a demand

among retail stores and with particular buyers. Those sold in case lots will go to clubs, hotels, steamship lines, or other large consumers and retailers.

Making Returns.

This phase of the subject has caused the committee the greatest amount of work and is, perhaps, the most important part of the plan. * * * Because of the extra work involved in grading and packing, and because we have to insure this *"one price and one commission"* innovation, the percentage of commission allowed to the agent is double what has heretofore *apparently* been the case. We allow ten per cent. to the shipper and deduct an additional two per cent. to cover the cost or cartons, labels, etc. This will make a total of twelve per cent. to cover the cost of marketing. No doubt many will consider this almost prohibitive. In reply we can only say that we believe this committee has conducted the most exhaustive investigation into this subject that has ever been made for such a purpose. It is our belief that this commission is *no higher than the average commission charge in reality* on average shipments, by commission dealers and wholesalers. We do not believe that all commission men or wholesale dealers in eggs report receipts less than the prices actually received, but we do believe that producers are entitled to know just how their goods are sold and exact details connected with their disposal. Under present conditions such knowledge is almost impossible to get. More than that if there is going to be any money made by holding the eggs for a day or two, by storing them for a longer or shorter period, or by handling them in any manner, we believe the producer is the party who should profit by it. * * * This plan *does away with all "Queer Transactions."* Producers in the manufacturing business or in any other line *know* whom their goods are sold to, they *know* how much they are sold for, and they *know* how much it costs to sell their goods. In disposing of perishahle stuffs produced on the farm and sold in distant markets definite prices cannot be agreed upon by both parties in any practical way. * * * The producer has depended entirely upon the honesty of the dealer. The producer understood that the dealer was acting purely as his agent. An illustration of how far the present condition of the commission business is removed from this idea is seen by the action of many of the firms in New York City during the past year. The New York State law-making bodies enacted laws requiring the registration and filing of a bond with an authorized party,

of all persons doing a commission business and a more or less definite supervision of the business by the State. Many of the companies engaged previously in the commission business are now purchasing for themselves at their own prices the products from their shippers. In this way they go out of the commission business, and hence are not "hampered" by "foolish" laws. We believe that certain advantages as already mentioned, will be received by shippers who take advantage of this co-operative plan, and that the actual *cost will be no higher,* while the prices received for the eggs should be very satisfactory.

Duties of Local Associations.

Much of the success of this plan will hinge on the hearty support of the officers and members of the various associations about the State. The secretary of the local association must apply to the committee for "Shippers' numbers" in order to secure recognition by the agent for goods shipped by the members. The secretary should use his best judgment in calling for numbers, as there may be cases where careless individuals still persist in allowing their hens to consume food not consistent with the production of fine eggs.

The committee asks that the following facts be brought to the attention of each association by the secretary at a regular meeting.

1. Investigators in this and foreign countries who have studied the problem of food stuff distribution and its relation to the high cost of living agree that efficiency can best be secured through co-operative selling on the part of the producers and co-operative buying on the part of the consumers.

2. Of the various methods of disposing of eggs practiced by the New Jersey poultrymen most of them have serious disadvantages. Nearby markets are small and often very plentifully supplied. Only small producers can afford to keep up retail trade. By sending eggs to dealers in distant cities no assurance can be had that the returns are what they should be. Is there not a great need of a well perfected method of marketing, for raisers located in rural communities? Is there not room for *improvement in prices received by all?* Does not New York City, especially, afford a most promising market for superior eggs, packed and sold right? Have we not learned by the example of our enterprising friends in distant sections that co-operative marketing has great practicable possibilities?

3. No such extensive co-operative plan for the handling of eggs has ever been introduced or tried out in this country. New Jersey is the foremost poultry State in the Union. We have an unusually high class of efficient and progressive poultrymen. This State should take the lead in co-operative selling methods, and the poultry producers of the State should be glad of the opportunity of giving their support to such an effort.

4. On account of the agitation and publicity given to the subject of co-operation during recent years it would seem that *now* is an especially desirable time to take the initiative in this step and inaugurate a truly co-operative method of dealing from farm to consumer.

5. Notwithstanding the failure of many previous co-operative efforts which have been tried out, this plan embraces certain factors that are de-

serving of attention. Whereas in the past many so-called propagandas have been supported by commercial interests, this plan has been *suggested, organized and adopted by a group of actual producers*. In the past many co-operative efforts have been supported by only a few shippers, necessitating an irregular supply of products, with great scarcity at certain seasons. Our plan embraces thousands of members, and because of this State-wide scope, should include every one who produces eggs in large enough quanities to ship to the large markets.

6. Finally, the committee desires to state that this plan of co-operative marketing is the result of the experience and study, not only of its members, but also of the best authorities upon this subject in the United States.

The success or failure of this plan depends upon those who have to do with it in its early life. The firm *establishment* of this method is the *important* thing and we hope that everyone will *boost* and that *criticisms* will be withheld until a thorough trial is given.

The Committee.

The committee appointed for the purpose of outlining and organizing this co-operative plan consists of A. L. Clark of the Experiment Station, chairman; Mr. M. K. Boyer, the well-known poultry authority of Hammonton, and Mr. George P. Dearborn, formerly of the firm of Dearborn & Sharpe, poultry farm proprietors of Blairstown, but now removed to Florida. The committee can be reached at any time by addressing the Chairman at the Station in New Brunswick.

The Committee will order supplies, such as cartons, labels, printed slips, gummed numerals, etc., and distribute them as may be necessary It will be ready at all times to consult with growers on any feature of the co-operative plan or in regard to management methods. It will visit the agent at frequent intervals and keep in close touch with the development, standing and condition of the plan.

A complete report will be made by the committee at the annual meetings of the Federation.

Factors That Go to Make Up Quality Eggs.

The term fresh eggs at the present time means absolutely nothing. The average city housekeeper or small buyer knows of but two kinds of eggs, fresh eggs and cold storage eggs. The expert egg dealer knows of a dozen grades, more or less, of fresh eggs and several of the cold storage variety. If it is the object of this association to make a specialty of the very finest eggs, then the individual members who are producers should know what factors will count when the agent grades his eggs and makes his returns according to the quality received.

FRESHNESS. This quality is recognized by the trade in general as well as by the consumer as the prime requisite for good eggs. Our eggs should

be placed in the hands of our agents as frequently as possible. In the season of cool weather hens naturally lay very poorly, and it often becomes necessary to hold eggs a week in order to fill a case for shipping. This holding may be done to some extent where a suitable storing place is used and the temperature is kept low. Late summer and fall is the time of the year when farmers endure greatest loss from the temperature. It is recommended that where a shipper wishes to ship his eggs, and having but a small flock is not able to secure a case full within a few days in warm weather, that his local association take the matter up and endeavor to have several such members ship together.

SIZE. For some years there has been some demand that eggs be sold by weight. Whether this condition will ever come about or not we do not know, but we do know that although eggs are sold by the dozen in most eastern markets, weight does count, and eggs which bring a premium on particular markets must be of large size and weigh one and one-half pounds a dozen or more.

CLEANLINESS. This factor is not a difficult one for any poultryman to secure in his product. Plenty of litter on the floor of the hen house, with clean nesting material, darkened nests and removal of broody hens, will insure a low percentage of soiled eggs. Washed eggs are better than dirty-shelled eggs, but it must be remembered that Nature has placed a so-called "bloom" upon the shell, and in washing, this is removed and the pores of the shell opened. Consequently deterioration sets in easily in washed eggs.

FLAVOR. Nearly all eggs in their fresh stage are of good flavor. Occasionally, however, the effects of certain food seem to be transmitted in the eggs. Thus we find sometimes what we know as "grass eggs." These eggs are supposed to be laid by hens which have been without green food for a period, and then suddenly have been allowed all they want. The feeding of fish or onions is to be avoided. Of late years better processes of curing fish refuse have been invented, and some poultrymen use this as a protein carrier in their feeding rations with no ill-effects. The feeding of fresh oyster shells has been known to cause a disagreeable flavor in the eggs. During the spring of the year many poultrymen have complaints regarding blood spots in their eggs. This is a condition usually found in pullets during a period of heavy production. Outside range with plenty of green food will usually benefit this trouble.

INFERTILITY. This is a subject which undoubtedly is of much importance to the western producer. In the east, however, eggs produced by flocks containing male birds and marketed within a short time can be in no wise inferior to infertile eggs.

SHIPPING. It is probable that all of our eggs will be shipped by express. When eggs are to be shipped by express, second hand standard egg cases will probably be found most economical. The agent can be depended upon to supply these cases complete with fillers at the lowest possible price. Where possible these cases should be secured by the carload for all members of local associations, in order to save the freight. Care should be used that only strong, sound fillers are used. Oftentimes one or more fillers in the case will show signs of previous breakage. Such fillers are very apt to prove weak and should be discarded. When packing a case, be sure that a small cushion of excelsior is used to cover the bottom. On this place the first flat and fill the case to the top. On the surface of the upper flat, before nailing the cover on, place another cushion similar to the bottom one. Nail the cover only at both ends, and not in the center. This affords a slight bulge, and with plenty of excelsior absorbs considerable shock when the case is roughly handled. Shippers will be supplied with shipping tags, and two of these are to be placed on each case. Before shipping as much information as possible should be secured as to

the route and express service to the destination. It may be possible for the local association to take this matter up with the express company and secure lower rates and better service, especially if a considerable quantity of eggs are to be shipped. When more than one route is available, the quickest and most reliable should be chosen. Transfer points prove to be danger spots for fresh egg shipments. Cases of fine eggs, be they ever so fresh, take on quite different characteristics if left over on a hot, sunny platform for a couple of days.

REFRIGERATION. It is possible that our co-operative efforts will give rise to increased profits from our eggs because of the possibilities of storing a certain proportion of our fine spring eggs when prices are low and bringing them out to be sold when our supply runs short. If this is done these eggs will, of course, be sold as refrigerator eggs.

Summary.

A few of the interesting features of this co-operative project may be briefly summarized as follows:

1. No additional work or inconveniences are necessary on the part of the producer.
2. The advantages to the producer arising from having a personal interest in the disposal of the eggs and a control over the methods pursued should lead to quick returns, a perfect understanding between producer and distributing agent, etc.
3. It will be possible to secure the highest price possible where such limited expense in distribution is incurred.
4. It will be possible to build up better marketing facilities year by year by reason of experience gained and reputation secured.
5. A feeling of confidence and security will be generated the knowledge that our eggs are being sold to the very best advantage and that we know just how they are sold and are receiving every cent that belongs to us.
6. It will mean advertisement, publicity and prestige for the poultry business in New Jersey.

At this writing there is an effort being made to form a State-wide Poultry Association in which the dues shall be twenty-five cents a year for State membership and one dollar a year for local membership; one of the rules of the State Association being that any member belonging to the State Association must be an active member of a local association. Such an association will be the authorized representative of the American Poultry Association, will have its duly elected officers and committees, and should be a patent factor for the proper development and maintenance of the industry in the State.

During the past year members of the Poultry Department have given over 150 lectures on poultry husbandry, with a total attendance of approximately 10,000 persons. Many of these lectures have been illustrated, stereopticon, charts having been used freely; and some of them have been in the form of demonstrations in which the operations under discussion were performed in the presence of the audience.

The correspondence of the Department has reached the gross total of 6,000 letters for the year just concluded. Approximately half of

these letters have been of an extension nature, while the balance have pertained to administration, etc. These letters have been answered in part by all members of the Department, each having his own special subject to handle. In the work of answering correspondence the "Hints to Poultrymen" have been freely used. Many blue prints of poultry houses and appliances have been prepared. These have been distributed to poultrymen upon request, the nominal charge of ten cents being made to cover the cost of printing.

The work which has been under way for the past two years to determine the cost, amount and duration of egg production under farm conditions has been under the direct supervision of Mr. A. L. Clark. It is very gratifying to know with what interest and co-operation the poultrymen in the State have aided in this work.

A number of the Associations have promoted the idea of the Boys and Girls Poultry Raising and egg laying contest, notable among them being the Middlesex County Poultry Association. This work was also under the supervision of Mr. Clark. * * * The Poultry Department believes that through interesting the younger generation in the work a firm foundation can be laid for greater advances in poultry husbandry. The records used in this work will doubtless be of interest to many, and are here given with the hope that other poultry Associations in the State will interest their local school authorities in such efforts, and thus promote greater interest among the young people.

Over two hundred inspection and advisory trips have been made to points in the State at owners' requests. Such trips have covered problems pertaining to the layout of poultry plants, proper methods of feeding and management, better houses, disease determination and prevention, and other poultry questions. Many diseased birds have been sent to the Department for diagnosis, such work having been carried on by Mr. Thompson. The following is a report of his findings.

Disease Diagnosis Report.

During the past year careful attention has been given to a new line of effort in this Department, namely, that of the diagnosis of poultry diseases. Two hundred and thirty-five cases of poultry diseases have been carefully examined in the laboratory of this Department. Diseased specimens have been sent in from all sections of the State. At the beginning of the year a card of information was prepared and distributed among the various poultry Associations in the State with the hope that it would inform poultry raisers who might be suffering losses from poultry diseaes as to how a diagnosis of su-h diseases might be
from poultry disease as to how a diagnosis of such diseases might be
obtained. A copy of the card follows:

NEW JERSEY AGRICULTURAL EXPERIMENT STATIONS.

NEW BRUNSWICK, N. J.

Poultry diseases are accountable for the greater part of the serious losses that are suffered each year in poultry raising areas. Many of the losses could have been averted, if a careful diagnosis of the diseased birds had been made. If a disease is identified, especially in the earlier stages, steps often can be taken toward preventing the spread of the infection, or correcting the causative conditions, if it is not a contagious trouble. In order to be of service to the poultry raisers of New Jersey in this respect the Poultry Husbandry Department of the New Jersey Agricultural Experiment Stations will make a careful examination of sick or dead birds sent to the department, as per directions below. In so far as possible letters will be sent stating the probable causes, symptoms, treatment and prevention of the trouble in each case. This will be done free of charge, except that express charges must be paid by parties sending birds for diagnosis. More satisfactory results will often be obtained in cases where it is possible to send in the sick birds. In cases where the birds have died and it is desired to send in the bodies for examination, care should be taken to send them in as good a condition as possible. In making shipment of either dead or live birds, please follow the suggestions below:

1. Send all boxes by Prepaid Express.
2. Pack dead birds in strong boxes which Will Not Be Broken in Transit.
3. In warm weather pack dead birds in Ice, to prevent decay.
4. Send dead birds as Soon After Death as possible.
5. Send dead birds at the First of the Week, or so they will reach this office Before Saturday.
6. Accompany all shipments with a letter answering the following questions. (VERY IMPORTANT):
   a. How long was the bird, or birds, sick?
   b. How many have been similarly affected?
   c. How did they act ?
   d. Did you notice any signs of diarrhoea ?
   e. Did they lose their appetite ?
   f. What was the color of the comb and wattles before death?
   g. How have you been feeding the birds ?
   h. In what kind of quarters are they housed ?
7. Address all letters to W. C. Thompson, Poultry Dept., College Farm, New Brunswick, N. J.

The Poultry Department stands ready upon request, to make diagnoses of diseased specimens whenever they are in such a condition that it is possible to do so. A letter of information concerning the length of time that the fowls have been sick and any symptoms that may have been shown before death, has been required. After an analysis of diseased conditions has been made a letter of advice is forwarded to the party sending the specimen. The result of this work during the past year has been very gratifying in that many poultrymen in the State have taken advantage of this opportunity. It is hoped that many epidemics of disease have been avoided. * * *

There have been approximately fifty different diseases found in the 235 specimens examined. The most common was eye roup, a disease slightly contagious in nature, that is prevalent during the winter and spring seasons. It is caused undoubtedly by an organism, the exact identity of which is questioned, which gains entrance into the nasal passages of the cavity below the eye. It causes a watery secretion to flow from the eye which is followed by a more or less severe swelling. Accompanying this is a very disagreeable odor and the accumulation of large cheesy deposits. In all cases immediate isolation of diseased birds was advised. Further treatment with potassium permanganate has been suggested as the most practical method of combating the disease.

Enough of this material should be used in the drinking water of the fowls during the winter and spring season to make the water a bright cherry red color. A stronger solution should be made in warm water and used as a wash for the affected parts of sick birds.

At the same time of the year there have been numerous reports of cases of chicken pox, canker, bronchitis and catarrh. The importance of sanitation has been emphasized particularly in cases of outbreaks of these diseases. It is advisable to keep the drinking fountain absolutely sanitary throughout the winter, especially as this fixture is the most efficient path to the spread of infection of roup and kindred diseases. Scald all water fountains at least every other day. Cleanliness about the entire poultry house is an absolute necessity in the control of diseases of this nature.

There have been numerous cases of tuberculosis reported. This is a disease which is more or less common throughout the country. It has not been considered serious by many poultrymen because it is slow to act and may take off but a few fowls in a flock during one season. In all cases examined the common symptoms of tuberculosis were exhibited, namely, emaciation commonly called "going light," and general loss of strength and vitality. Upon post mortem examination enlarged livers were found, covered with hard, yellowish spots. Again the complete sanitation of the environment of fowls is the natural and satisfactory method of controlling this disease.

Prolapsis of the oviduct was a trouble diagnosed in a great many cases during the winter and spring. This trouble consists of a more or less complete eversion of the lower part of the oviduct or the channel through which the egg passes. This occurred in the cases of pullets under heavy egg production, also in the case of old fowls that had been forced heavily during the first year or two of production. Immediate isolation of all affected birds was advised. No medical treatment is necessary except to keep the birds in warm, dry, clean quarters where nature can heal the wound. This is not necessarily a fatal disease. Where sick fowls are allowed to remain in the flocks with other birds "cannabilism" is often started. Birds will often pick at a sick individual and thus get the taste for blood and flesh.

This work will be carried on throughout the coming year and careful records kept of all cases diagnosed.

Statistical Work.

It is generally accepted that New Jersey as a State is the most intensive poultry producing section of its kind in the United States.

More breeds are represented, more large farms are found, and better financial results are secured both in total amount and profit per bird. than in any other section. The securing of statistical data which will enable us more fully to appreciate conditions as they exist is now under way. The figures when complete will be of value in promoting and developing the work, and will be published in bulletin form. The statistical work is now in the hands of Mr. Victor G. Aubry, the new Extension Specialist in Poultry Husbandry. Mr. Aubry, together with the other members of the Department, will meet in a personal way as many poultrymen of the State as possible during the next year.

Conclusions.

With our new poultry farm under way, with increased funds for its completion and with the increase in the poultry staff, more attention to details and specializations made possible. More and better work during the ensuing year is assured.

Respectfully submitted,

HARRY R. LEWIS,
Poultry Husbandman.

Nov. 20, 1914.

Report of Dairy Husbandman.

ALFRED S. COOK.

The work of the Dairy Department during the last fiscal year has been continued along the same lines of work as last year. Two feeding experiments have been conducted, one dealing with silage as a feed for growing dairy calves and heifers, and the other with alfalfa hay as compared with soiling crops as a feed for dairy cows during the Summer months. Records giving the production and cost of production in the dairy herd have been continued as well as the study of the cost of raising calves, which was started last year.

The Dairy Husbandman has given lectures during the year at institutes, grange meetings and other farmers' gatherings. At these lectures much discussion has been given to Cow Testing Association work.

However, the Dairy Husbandman feels that more associations should not be organized until the Department is in a position to give them supervision. This would require the greater part of one man's time.

Practically the same amount of advanced registry work has been done during the year, except that there has been a slight increase in the amount of Holstein work. Feed records have been kept of all feed fed cows on advanced registry test, and are on file in the office.

NEEDS OF THE DEPARTMENT.

If a study nf the cost of raising calves is continued in the dairy herd, it will be necessary to have a building suitable for housing the young stock of the herd. There should be better representatives of the Guernsey and Ayrshire breeds in the herd than are owned at present. Three or four good representatives of each breed would be sufficient to meet the requirements for teaching work and as breed specimens.

The advanced registry work of the State has grown within the last few years until it is practically impossible to conduct it strictly in accordance with rules of the Breed Associations, with the present organization of this Department.

Much of the Dairy Husbandman's time during the past year has been devoted to teaching in the Short Courses, and to the College Course in Agriculture, and if the advanced registry work, Cow Testing Associations, and other dairy organizations are to receive continued support, it will be necessary to have additional help in the Dairy Department.

FEEDING EXPERIMENT.

Alfalfa Hay versus Soiling Crops.

Although corn silage is considered one of the best feeds with which to supplement pasture, it often occurs that silage alone will not furnish a sufficient amount of roughage. This is especially true if the pasture is very short; and occasionally we find cases where both silage and soiling crops are fed.

In previous years the dairy herd at the College Farm has been fed silage and soiling crops as roughage during the Summer months, but, owing to the extra amount of work necessary in furnishing soiling crops regularly, it was thought that it might be more economical to use cured alfalfa hay with the silage, rather than green soiling crops. The object of this experiment was: 1. To determine the feeding value of cured alfalfa hay as compared with green alfalfa fed as a soiling crop for cows producing milk. 2. To determine the physical effect of green alfalfa fed as a soiling crop with silage, as compared with alfalfa hay.

Plan.

Fourteen cows were selected in conducting the experiment, but on account of a case of foot rot, one cow in Group 2 decreased considerably in production during the experiment, and was eliminated in the results given. This made it necessary to remove one cow of approximately the same weight and production from Group 1. In making up the Group for the experiment, care was taken to have the weight and milk production uniform in each group. The average lactation period is also practically the same in each group. The arrangement of groups were in four periods, as follows: first 10 day Preliminary, first 40 day Experimental, second 10 day Preliminary and second 40 day Experimental. Alfalfa hay ration was used by Group 1 in the first two periods and by Group 2 in the next two. Soiling crop ration was used by Group 2 in the first two periods and by Group 1 in the next two.

The experiment covers a period of 100 days, 50 days being devoted to each ration. The first 10 days of the experiment were devoted to a preliminary period, and immediately following the first 40-day experimental period, another 10 days was devoted to the change of one group from one ration to another. This period is allowed in order that the cows may become accustomed to the change. In comparing results of the experiment only the production during the experimental periods is considered.

Rations Fed.

All feed received by the cows during the entire experiment was fed in the barn. They had access to a small exercise lot, which did not furnish any pasturage. Practically the same amount of feed is fed to each group in the experimental periods.

The average daily rations fed in experimental periods, together with the nutrients contained in each ration, are as follows.—

ALFALFA HAY RATION.

	No. of Lbs.	Lbs. Dry Matter.	Lbs. Protein.	Lbs. Carbo-hydrates.	Lbs. Fat.
Alfalfa hay	12	11 28	1.404	4 920	120
Silage	35	9.10	420	4.900	.245
Beet pulp	2 67	2.45	.109	.173	.
Corn meal	1 95	1 73	.154	1.306	.083
Gluten	.515	468	.109	.272	.014
Distillers' grains	.725	.667	.165	290	.084
Cotton seed meal	605	.562	.227	.127	.058
Bran	62	545	073	260	.015
		26 802	2 657	12 178	.619

SOILING CROP RATION.

	No. of Lbs.	Lbs. Dry Matter.	Lbs. Protein.	Lbs. Carbo-hydrates.	Lbs. Fat.
Silage	35 15	9 13	42	4 92	.246
Soiling crops	30	8.46	1 08	3 63	.120
Beet pulp	3	2 76	123	1.95	....
Corn meal	2.18	1.94	172	1.46	.093
Gluten	.112	.101	.023	.059	003
Distillers' grains	.545	501	.124	.218	.063
Cotton seed meal	545	.506	204	114	052
Bran	545	479	064	.228	013
		23 877	2 210	12 579	590

The alfalfa ration contains slightly more dry matter and protein than the soiling crop ration. The cows on the soiling crop ration were expected to consume 35 pounds of soiling crops per day, but during the first 10-day preliminary period they refused to eat this amount, and 30 pounds per day were fed during the remainder of the experiment.

The total feed fed on the alfalfa ration as compared with the soiling crop ration was practically the same in both groups, and 5,760 pounds of alfalfa hay were fed in this ration and 14,400 pounds of green feed in the soiling crop ration. During the last 10 days of the experiment the supply of green alfalfa became exhausted and green kafir corn and soybeans were fed in its place.

Table No. 1.

Total Feed Fed to All Cows.

NAME OF FEED.	Alfalfa Hay Ration.		Soiling Crop Ration.	
Alfalfa hay	5760	$57.60	....	....
Silage	16800	42 00	16786	$41 96
Green Feed	....	..	14400	36.00
Beet pulp	1284	17 97	1282	17 94
Corn meal	936 2	14.07	940 5	15 04
Gluten	464.5	6 96	471 1	7.06
Ajax	350 5	5.60	340 7	5 45
Cotton seed meal	291.5	4 66	287 6	4.60
Bran	296.3	4 14	287.6	4.02
Totals		$153.90		$132 07

Weights.

During the experiment each cow was weighed every 10 days. The weights given represent averages for two days. This was done in order to eliminate, to a certain extent, the daily variation in weight.

The weight of the different cows remained practically uniform throughout the experiment, except that there was a slight gain in weight for all cows in Groups 1 and 2.

Following is a summary of the average weights per cow given on the alfalfa hay ration as compared with the soiling crop ration:—

Number of Cow.	Alfalfa Hay Ration.	Soiling Crop. Ration.
56	931	985
44	1,043	1,046
54	969	1,049
66	831	872
68	1,042	1,127
65	699	734
3	1,078	1,055
57	835	843
2	940	890
55	997	957
69	991	948
59	1,058	1,030
Total weight of Group 1 and 2	11,414	11,536
Average weight of Group 1 and 2	951	961

Both groups maintained their production exceptionally well throughout the entire 100 days. The average production of each group during the first experimental period was practically the same as the average production in the second experimental period. This not only holds true in the case where Group 1 is changed from alfalfa to soiling crops, but it is also true of Group 2 where the change has been made from soiling crops to alfalfa. The weather conditions during the second experimental period were much more favorable than during the first, and this probably accounts to a cretain extent, for the exceptional way in which both groups maintained their production during the 100 days they were on experiment.

A summary of the milk and butterfat production on the different rations is as follows:

GROUP 1.	ALFALFA HAY RATION.			SOILING CROP RATION.		
	Milk.	Fat.	Fat.	Milk.	Fat.	Fat.
	Lbs	%	Lbs.	Lbs.	%	Lbs.
Cow No. 56	1115 3	2 6	30 02	1234 9	2 7	34 01
Cow No. 44	1099 4	3 4	38 07	900 0	3 5	34.85
Cow No 54	907 6	2 9	26 38	1167 7	3 1	36 31
Cow No. 66	832 2	2 9	24.65	774 1	3 2	25.43
Cow No. 68	646 0	3 4	22 33	503 6	3 6	19 53
Cow No. 65	698.3	2 8	19 68	697 5	3 1	21.79
Totals	5298 8	3 04	161 13	5367.8	3 22	171.92
GROUP 2.						
Cow No. 3	1369 3	2 8	39.15	1107.5	2 8	33.12
Cow No. 57	1111 5	4 0	44 94	1226.4	3.8	47.27
Cow No. 2	667.4	3.1	21 22	752.8	3.3	25.03
Cow No. 55	856.5	3 2	28.07	858.4	3.0	26.36
Cow No. 69	854 6	4 0	34.40	873.8	3.6	31.76
Cow No. 59	802 1	3 6	29.54	820.4	3 5	29.50
Totals	5661.4	3.48	197.32	5729.3	3.38	193.04
Totals, Group 1 and 2	**10960.2**	**3.27**	356.45	11097 1	3.29	**364.96**
Daily Avg. per cow	**22.82**	3.27	.746	23.11	3.29	**.760**

Costs of Production.

In order that the cost of production when the alfalfa hay ration was fed', might be compared with the cost with soiling crops, the feeds used have been given a value which corresponds to the market value of the feeds at the present time; and the cost of feed, profit over feed cost, etc., has been figured with each ration.

Table No. 2 gives a summary of the production on each ration, with the cost of feed and profit over feed cost. In estimating this cost, the following values were placed on the different feeds. Roughage—Alfalfa hay, $20; ensilage, $5; soiling crops, $5. Concentrates—Corn meal, $32; gluten, $30; distillers' grains, $32; cotton seed meal, $32; wheat bran, $28; beet pulp, $28.

The question as to which is the most economical feed can be decided only by the cost per ton of the alfalfa, as compared with the cost per ton of the soiling crops. Generally speaking, where alfalfa can be raised in large quantities at a low cost, this also applies to soiling crops. Another factor which must be considered in connection with the soiling crop ration is that a great deal of time is required in cutting and hauling a certain amount to the barn each day. This necessitates extra work and should be taken into consideration in the cost of the soiling crops as a feed.

Table No. 2.

Yield and Costs of Producing Milk and Butterfat.

RATIONS.		PRODUCTION AND VALUE OF MILK.				COSTS TO PRODUCE.				
	Number of days.	Milk.	Fat.	Butterfat.	Value of milk.	Cost of feed.	Profit over feed cost.	Cost one qt. milk.	Cost 1 lb fat.	Returns for $1.00 expended.
		Lbs.	%	Lbs.						
Alfalfa hay	80	10960 2	3.27	358 45	$254.81	$153.90	$100.91	$ .030	$ .42	$1 64
Soiling crop. . .	80	11097.1	3.29	364 96	258.06	132 07	125.99	025	.36	1.95

Summary.

1. Records carefully taken during the experimental periods show that the total average weight of Group 1 and 2 on the alfalfa hay ration was practically the same as an the soiling crop ration. The average weight of Group 1 and 2 on the alfalfa hay ration was 951 pounds and the average weight of Group 1 and 2 on the Soiling crop ration 961 pounds.

2. The production of both Group 1 and 2 remained remarkably constant during the entire experiment on both the alfalfa hay and soiling crop rations.

3. Total production of milk from both Groups on the alfalfa hay ration was 10960 pounds, as compared with 11097 pounds on the soiling

crop ration, and the average daily production was 22.6 pounds when alfalfa was fed as compared with 23.1 pounds on the soiling crop ration.

4. Percentage of butterfat and pounds of fat was as follows: 3.27 per cent. fat, 358.4 pounds fat on the alfalfa hay ration, and 3.29 per cent. fat and 364.9 pounds fat on the soiling crop ration.

5. Expressed in percentages, the soiling crop ration produced 1.2 per cent. more milk and 1.8 per cent. more fat than the alfalfa hay ration.

6. Based on the prices given, the cost of feed was $153.90 and the profit over feed cost $100.91 on the alfalfa hay ration, as compared to a feed cost of $132.07 and profit over feed cost of $125.99 on the soiling crop ration.

7. For every pound of alfalfa hay that was fed 1.9 pounds milk was produced, and it required 2.68 pounds of green alfalfa fed in the form of a soiling crop to produce 1.9 pounds of milk.

FEEDING EXPERIMENT.

Silage versus Soiling Crops as a feed for Dairy Calves and Heifers.

Experiments conducted with corn silage have shown that it is one of the most economical feeds that can be fed to cows producing milk. One of the most important advantages in its favor is the fact that it can be economically stored in large amounts and can be fed at any time during the year. It has proved to be of great value in supplementing pasture during the Summer, when dry weather has caused a shortage of pasture grass.

As silage has proved to be such a valuable feed during the Summer for dairy cows, it suggests the question as to whether it is as economical to feed for growing calves and heifers as it is for milk production. It was the object of this experiment to determine the effect of feeding silage, as compared with soiling crops to calves and heifers.

Plan.

Six calves and six yearling heifers were selected for conducting the experiment, and were divided into two groups, known as Groups 1 and 2. Each group is made up of three calves several months of age, and three heifers over one year old. Care was taken to select calves and heifers for each group, so that the average weight and age would be practically the same. The arrangement of groups during the feeding experiment was the same as in the last experiment.

The preliminary periods are allowed in order that the calves might become accustomed to the rations, and results of the experiment are drawn from data collected during the experimental periods only.

During the first preliminary and experimental periods Group 1 received soiling crops, while Group 2 received Alfalfa hay and silage. At the end of the first experimental period the groups were alternated, Group 2 receiving the soiling crop ration and Group 1 the silage ration.

During the entire experiment each group was kept under the same conditions. Yearling heifers were turned out in an exercise yard regu-

larly, and the younger calves were kept in pens in the barn. Care was taken to see that all calves received the same exercise during the experiment. Both groups were fed regularly at the same hour of the day, and weighed at the same hour of the day. Total weight of Group 1 at the time the experiment began was 1805 and the total weight of Group 2, 1868. Average age of animals in Group 1 was 7 months, and in Group 2, 7½ months

Rations Fed.

Table No. 1—Rations Fed Per Day.

		SOILING CROP RATION.						ALFALFA HAY AND SILAGE RATION					
	Calf No.	Alfalfa Hay	Soiling Crops	Corn Meal	Bran	Oats & Peas	Skim Milk	Alfalfa Hay	Silage	Corn Meal	Bran	Oats & Peas	Skim Milk
		Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.
GROUP No. 1.	44	5	13	1 0	1 0	1 0	. .	5	20	1.0	1 0	1 0	.
	63	5	13	1 0	1.0	1.0	.	5	20	1 0	1 0	1.0	. .
	5	4	10	1.0	1.0	1 0	. .	4	13	1.0	1.0	1.0	. . .
	1	1	6	5	5	.5	16	1	1	.5	.5	.5	16
	56	1	1	3	3	.3	16	1	1	3	.3	.3	16
	9	1	1	.2	.2	.2	16	1	1	.2	.2	.2	16
Total		17	44	4.0	4.0	4.0	48	17	56	4.0	4 0	4 0	48
Average.		2.8	7.3	.7	7	.7	8	2.8	9 5	7	.7	.7	8
GROUP No. 2.	38	5	15	1 0	1.0	1.0	. .	5	25	1 0	1 0	1 0	. . .
	16	5	15	1.0	1 0	1 0	. . .	5	3	1.0	1.0	1.0	.
	15	4	13	1 0	1.0	1 0		4	10	1 0	1 0	1.0	. .
	65	1	7	.5	.5	.5	16	1	6	.5	.5	.5	16
	2	1	2	.3	3	.3	16	1	2	.3	3	3	16
	44	1	1	.2	.2	.2	12	1	1	.2	.2	.2	12
Total.		17	53	4 0	4 0	4 0	44	17	57	4.0	4.0	4.0	44
Average.		2.8	8 8	7	7	7	7.3	2.8	9.5	7	.7	.7	7.3
	SUMMARY.												
Total Group 1 and 2.	. . . .	34	97	8.0	8 0	8.0	92	34	113	8.0	8.0	8.0	92
Average.	. . . .	2 8	8.0	.7	.7	.7	7.6	2.8	9.4	.7	.7	.7	7.6

Table No. 1 gives in detail the ration fed to both Group 1 and 2. The soiling crops are considered together and an average analysis given of the different kinds of feed. Soiling crops consisted of green alfalfa for practically the entire period. During a short time, in the second experimental period, green soy beans were fed in place of alfalfa, and for a short time during the first experimental period green oats and peas were supplemented. An average analysis of the three soiling crops is given in this table. The summary shows that the average daily soiling crop ration is practically the same as the silage ration, and the grain mixture fed remained the same during the experiment. These rations were compounded at the time the experiment started and no change was made except in the kind of soiling crops. During the first ten-day period the calves were allowed to consume all of the grain and roughage they wanted, and this was fed throughout the entire experi-

ment, except in a few cases where the calves refused to eat the total amount. In this case the feed refused was deducted from the total amount fed and figures given represent the actual amount consumed.

Table No. 2—Nutrients Furnished in Experimental Periods.

Kind of Feed.	Lbs.	Average Soiling Crop Ration.				Average Silage Ration.			
		D.M.	Pro.	Car.	Fat.	D.M.	Pro.	Car.	Fat.
Skim milk	7.6	.71	.220	.403	.023	.71	.220	.403	.023
Alfalfa Hay	2.8	2.62	.328	1 147	028	2 62	.328	1.147	.028
Silage	....	....	....	....	....	2.48	.117	1.337	.065
Soiling Crops	8 0	1.84	.212	.964	.032	....	....	....	....
Corn Meal	7	62	.055	047	.030	62	.055	.047	.030
Bran	7	.62	083	029	018	.62	083	.029	.018
Oats and Peas	7	60	104	357	014	60	.104	.357	.014
Total	..	7 01	1 002	2.047	145	7.65	.907	3 320	178

Average Requirements of Group I .... Pro. .210, Car. 2 105, Fat .030
Average Requirements of Group 2 .... Pro. .217, Car. 2.170, Fat .031

Table No. 2 gives the approximate nutriments contained in each of the experimental rations, together with the requirements for the average calf in Groups 1 and 2. These requirements are based on Haecker's Maintenance Standard for milk production ,and an excess of protein and carbohydrates was allowed for the growing animals. Each ration contains practically the same amount of protein and carbohydartes.

Weights of Calves.

All calves were weighed regularly every 10 days throughout the experiment. There was considerahle variation in the average daily gain per day in different periods. This seemed to be due to weather conditions rather than to the feed fed. All calves were in a normal condition during all periods and any variation in gains during different periods is not due to scouring or any other abnormal physical condition of the animals.

Although there is this variation in gains during different periods, the average gain in weight during the entire experiment is practically the same in both groups. Where there is a comparatively small gain during one 10-day period, it seems to be made up during the next. The cause of this variation offers an interesting field for continued investigation, as there is a similar variation in the average rate of gain from one month to another of all calves raised in the dairy herd.

Table No. 3.
Summary of Weights and Gain Per Day.

	SOILING CROP RATION.					SILAGE RATION.				
	Preliminary periods.	Experimental Periods.				Preliminary periods	Experimental Periods.			
	10 days.	10 days.	10 days.	10 days.	10 days.	10 days.	10 days.	10 days.	10 days.	10 days.
	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.
Total Group 1 and 2..	4038	4192	4273	4468	4672	4117	4220	4388	4500	4757
Gain.	....	154	81	195	204	....	103	168	112	257
Avg. gain per calf...	....	1 28	.67	1 62	1 70	....	.85	1 40	.93	2 14

Total Gain in weight of Group 1 and 2 on Soiling Crop Ration, 634 pounds
Total Gain in weight of Group 1 and 2 on Silage Ration, .. 640 pounds
Avg. Daily Gain in weight per calf on Soiling Crop Ration, 1.32 pounds
Avg. Daily Gain in weight per calf on Silage Ration, ... 1.33 pounds

The totals taken in 10-day periods also show considerable variation, as the average gain on the soiling crop ration is 1.28 pounds the first 10-day period and .67 pounds the next. There is more variation on the silage ration than on the soiling crop ration. The average gain per calf the third 10 days of the experimental periods is .93 lbs. per day, and the last 10 days 2.14 lbs.

Summary of Experiment.

1. The total gain in weight of both groups on the soiling crop ration was 634 lbs. as compared to 640 lbs. on the silage ration, there being a difference of only 6 pounds in weight.
2. Average daily gain in weight per calf on the soiling crop ration is 1.32 lbs. per day and on the silage ration 1.33.
3. The average daily soiling crop ration contains 7.01 lbs. dry matter, 1.002 protein, 2.947 carbohydrates and .145 fat, and the average silage ration 7.65 dry matter, .907 protein, 3.320 carbohydrates, .178 fat.
4. There was a total of 2052 pounds of nutrients fed during the time the soiling crop ration was fed, and 2217 in the silage ration. It required 3.2 pounds of nutrients for one pound of gain in the soiling crop ration and 3.4 pounds in the silage ration.

THE DAIRY HERD.

The dairy herd, at the time this report is written, consists of 71 animals, the majority of which are heifers and young stock. The four dairy breeds, Holstein, Jersey, Guernsey and Ayrshire are represented in the herd. Several representatives of the Guernsey and Ayrshire breeds are not exceptionally good animals, and from the point of production, should be disposed of as unprofitable. However, at present they are retained in the herd in order that a sufficient number of milking cows may be available for use in conducting experiments.

All Jerseys in the herd are good producers and exceptionally well bred. During the year a pure bred bull, Oxford Combine, No. 116287, was presented to the Experiment Station by Mr. George Batren,' a prominent Jersey breeder in Sussex County, New Jersey. This animal is very well bred and introduces a type into the herd that will blend exceptionally well with the types of Jerseys kept there.

An inventory of the herd taken October 31, 1912, and October 31, 1914, gives the number of animals in the herd both years, together with the number sold and purchased. This shows the natural increase in the number of animals in the herd, together with the approximate valuation in 1912 as compared with 1914. This inventory also shows that 16 Holstein cows have been purchased in the last two years at a cost of approximately $110 each. The majority of the cows were purchased in 1912 at an average price of $95. They were grade cows and this class of animals was purchased in order to have a sufficient number of individuals to do experimental work. However, the lactation production of these grade cows has averaged over 9,000 lbs., which is exceptional for this class of cows.

The summary:

1912			1914.		
			HOLSTEINS.		
Pure bred. .	5	$775	Pure bred. . .	6	$1,000
Grades. .	8	755	Grades	30	2,425
			JERSEYS.		
Pure bred.	4	$455	Pure bred. .	13	$1,675
			GUERNSEYS.		
Pure bred.	1	$125	Pure bred. .	2	$175
			Grades. .	3	300
			AYRSHIRES		
Pure bred	3	$300	Pure bred. . .	6	$630
			Grades. . .	1	75
			SHORT HORN.		
			Grade. . . .	1	$110
			BULLS.		
Pure bred. . .	3	$700	Pure bred.	7	$1,025
		$3,110			$7,415

COWS PURCHASED.		COWS AND BULLS SOLD.	
16 Holsteins.	$1,770	7 Holsteins.	$446
3 Jerseys.	500	1 Jersey.	50
4 Guerneys.	310	1 Guernsey.	110
1 Ayrshire.	130	1 Ayrshire.	75
1 Short Horn.	100	5 Bulls.	555
	$2,810		$1,236

Value of herd October 31st, 1914.	$7,415.00
Amount invested in purchased animals.	2,810.00
	$4,605.00
Amount received for animals sold. . . .	$1,236 00
	$5,846.00
Value of herd October 31st, 1912.	3,110.00
Natural gain in two years. . . .	$2,731.00

The following is a list of the amount and kinds of feed fed to the cows in the herd producing milk, and the prices at which the feeds are figured:

HAY AND SILAGE.

	Price per ton.	Lbs.
Alfalfa Hay	$20.00	80824
Clover Hay	19 00	1071
Timothy and Clover Hay	19 00	1768.5
Silage	5 00	290180
		373843 5

SOILING CROPS.

Green Rye	4.00	1020
Green Wheat	4 00	1308
Green Alfalfa	4.00	11694
Green Kafir Corn and Soybeans	4 00	6584
		20606

CONCENTRATES.

Corn and Cob Meal	$20 00	2777.4
Cotton Seed Meal	32.00	2825.7
Corn Meal	32 00	9450.6
Bran	27 00	7821 8
Ajax Flakes	32 00	8892.6
Soybeans	50 00	550.0
Green Oats and Peas	36 00	817.2
Hominy	28.00	7397 8
Gluten	30.00	3845 0
Jacqui Feed	32.00	392.0
Malt Sprouts	30 00	4188 6
Linseed Oil Meal	38.00	980.0
Beet Pulp	28.00	20919.4
		70858 1

Fourteen cows in the herd were on experiment during 110 days, and during this time uniform rations were fed regardless of the amount of milk produced. Another factor which has had a tendency to interfere with the milk production is the fact that it has been necessary to bring cows from the dairy barn to the judging pavilion, which is located about one mile away, for judging work with the students. During the time they were used they were kept in the horse barn near the judging pavilion.

Production, Feed Cost, and Profit.

Table No. 1 gives the milk and butterfat production, and profit over feed cost for each cow producing milk in the herd during the fiscal year. The average milk and butterfat production per cow was somewhat less than in the fiscal year, 1912-13. This was due to the fact that nine fresh cows were purchased in the fiscal year 1912-13, and the first six months of their lactation period was included in the year's average. There are also a number of heifers included in this year's record which freshened with their first calf during the year. Several cows were held over a dry period of four months in order that the dates of freshening of the cows might be uniform throughout the year, to insure as near as possible a constant supply of milk during the whole year.

There are several cows still in the herd, with records of between five

and six thousand pounds per year, which will be disposed of as soon as heifers freshen to take their places.

The cost of feed last year was $113.95 and this year $95.24. Expressed in percentages, only 47% of the value of the milk has been spent for feed. It should be remembered, in connection with this point, that the herd has been kept in the barn during the entire year, and at no time during the year has any pasture been available.

The production from the dairy herd during the past year has been sold in the form of cream and skim milk. The cream is separated and standardized to contain 40% butterfat, and is sold at a price of $.48 per quart. This is practically equivalent to .05 per quart for the milk, and the skim-milk from the herd is turned over to the Swine and Poultry Departments. The herd is credited with $.01 per quart for the skim-milk. This makes a total of $.06 per quart.

Table No. 1—Record of Production, Feed Cost and Profit.

NO. OF COW.	Months in test.	Pounds milk during testing period.	Average test.	Pounds butterfat during testing period.	Value of milk.	Cost of roughage.	Cost of grain.	Total cost of feed.	Total profit.	Returns for $1.00 expended for feed	Feed cost to produce 1 qt. of milk.
1	12	6,645.3	3.06%	203.90	$189.87	$58.94	$38.35	$97 29	$92.58	$1 95	$ .0307
2	12	5,018.0	3.42	171.47	141.28	56.73	40.71	97.44	43.84	1 44	.0407
3	12	8,303.5	2.43	202.00	237.79	57.53	43.14	100 67	137.12	2.36	.0254
5	8	3,347.1	3.98	133.34	112.42	40.48	25.08	65.56	46.86	1 71	.0411
12	3	2,569 3	3.43	88.28	73.45	16.75	10.90	27 65	45 80	2 65	.0226
15	8	4,405.0	4.14	182.73	120.12	38.57	27.63	66 20	53.92	1 81	.0315
16	8	4,441.3	5.01	222.73	126.88	37.24	27 68	64.92	61.96	1.95	.0306
17	4	3,528.7	3.12	110 15	100.86	23 92	19 75	43.67	57.19	2.30	.0259
18	4	4,377.7	2.70	118.50	125.19	23.20	20 70	43 90	81.29	2 85	.0210
19	3	2,885.4	2.70	78.01	82.48	20 31	18 03	38 34	44.14	2.12	.0279
11	4	2,593.6	4 77	123.85	74.13	21 23	16.67	37 90	36.23	1 95	.0306
34	12	9,376.1	3.08	289.60	267.65	64 66	48 75	113 41	154.24	2.36	.0254
39	8	3,084.3	4.91	151.64	88 13	42.24	21 85	64.09	24.04	1 37	.0436
40	10	4,156 7	2.97	123.75	118.74	45 05	23.56	68.61	50 13	1 73	0346
41	12	8,139.9	3.26	265.82	249 70	60 60	39 34	99 94	149 76	2 49	.0257
42	12	8,003.8	3 64	291 70	232.72	55 16	39 96	95.12	137 60	2 44	.0249
44	12	6,612.6	3.88	253.95	188.93	57 62	38 96	96 58	92.35	1 95	.0306
51	12	5,050 0	4.12	206.30	144 29	58.04	29 60	87 64	56.65	1 64	0358
52	12	6,024 5	4.38	263.96	178 13	59 41	29.00	88.41	89 72	2 01	.0371
53	12	6,590.6	3.99	263 09	188 31	59 69	35 54	95.23	93.08	1 97	0303
54	12	8,130.9	2.86	233.14	232.40	59.02	39 22	98 24	134.16	2 36	0253
55	12	6,473.1	3.13	202 94	184 93	55 11	37 38	92.49	92 44	1 99	0300
56	12	8,931 9	2 87	256.31	249.51	56.45	39 79	96 24	153 27	2 59	.0226
57	12	6,726 3	3.76	253.17	192.16	56 60	39 23	95.83	96 33	2 00	0299
58	12	6,265.1	3.65	229.00	179.00	50 29	32.72	83.01	95 99	2 15	0278
59	12	7,051.2	3.49	246.27	201 47	54 53	35 25	89 78	111.69	2 24	0267
60	3	2,268 7	3 10	71.50	64 53	15 96	14 48	30 44	34 09	2 11	.0281
61	8	4,676.8	3.29	154.14	133 60	35.85	25 26	61 11	72.49	2 18	0274
63	12	7,365.9	3.33	245.72	210 52	54.95	36 93	91.88	118 64	2 29	0261
64	10	5,770.3	3 55	205.20	167.14	40 74	26 00	66 74	100 40	2 51	0242
65	9	5,682.4	3.08	170 95	160.35	42 04	26 30	68 34	92.01	2 34	0252
66	5	3,044.5	3.12	96 15	87.00	28 26	13 46	41 72	45.28	2 08	.0287
67	2	1,642.7	3.52	57.90	46.21	12 28	11 06	23 34	22 87	1 97	.0298
68	10	5,318 9	3 44	183.10	152.15	45 91	28 71	74.62	77 53	2 03	0294
69	10	6,948 2	3.79	263.86	198.51	43 88	29 21	73.09	125 42	2.71	0224
8	8	3,088.3	3.64	112.42	89.42	33 64	17 89	51 53	37 89	1 73	0350
9	7	3,569.4	4.33	154.79	99.63	28.31	17 46	45.77	53.86	2 17	0269
46	1	694.3	3.39	23.60	19 84	6.04	4 03	10.07	9.77	97	0304
50	1	434.4	4.00	17.38	12.41	5 66	2 83	8 49	3.92	1 46	0440
Total	.....	169,236 7	3.47%	6,922 31	5,712 85	1,622.89	1,072 41	2,695.30	3,065.55	2 12	0280
*Average	28	7,040 1	3.47%	244 60	202 18	57.35	37.89	95 24	106.94	2 12	028

*Average per cow for 12 months.

The following statement shows the average production, feed cost, and profit over feed cost, per cow for the year, when milk is figured at $.05 and $.06 per quart and feeds figured at market prices.

	Milk @ 5c per qt	Milk @ 6c per qt.
Average lbs. milk per cow for 12 months	7040 1	7040.1
Average lbs. butterfat per cow for 12 months	242 84	242 84
Average value of milk	$167 62	$202 18
Average cost roughage	57 35	57.35
Average cost grain	37 89	37.89
Average cost feed	95 24	95.24
Average profit	72.38	106.94
Average returns for $1.00 expended for feed	1.75	2.12
Average cost to produce 100 lbs. milk	1.35	1 35
Average cost one quart milk	028	028

Statement of average production, cost of feed, and profit per cow with milk figured at $.05 and $.06 per quart, and when roughage is figured at the cost of production instead of market prices.

	Milk @ 5c per qt.	Milk @ 6c. per qt.
Average lbs. milk per cow for 12 months	7040.1	7040.1
Average lbs. butterfat for 12 months	242.84	242 84
Average value of milk	$167 62	$202 18
Average cost roughage	28.66	28.66
Average cost grain	37.89	37.89
Average cost feed	66.55	66.55
Average profit	101.07	135.63
Average returns for $1.00 expended for feed	2.51	3 03
Feed cost to produce 100 lbs. milk	945	.945
Average cost one quart milk	.0198	.0198

Cost of Producing Milk.

In the preceding data given of the production and cost of production in the herd, the only expense considered is cost of feed. In the following data other items such as labor, bedding, etc., are considered. Two calculations are given, showing the cost of production. In Calculation No. 1, all roughage feeds are figured at market prices, while in Calculation No. 2 the roughage feeds are figured at the actual cost of raising. These figures are taken from the College Farm field reports and are as follows:—

Alfalfa hay, $5.00 per ton; clover hay, $7.00 per ton; timothy and clover hay, $7.00 per ton; silage, $3.50 per ton; green rye, $4.00 per ton; green wheat, $4.00 per ton; green alfalfa, $3.00 per ton; Green Kafir corn and soybeans, $4.00 per ton.

The following items of labor, bedding, stabling, interest and depreciation on dairy utensils, are applied to the herd, which averaged 28 cows for the fiscal year:

Labor (one man) @ $1.50 per day (450 days)	$675.00
Bedding 1 ½ bales shavings @ $.22 per day (365 days)	120.45
Stabling at $5.00 per cow	140.00
Interest and depreciation on dairy utensils	50.00
	$985.45

The interest and depreciation on the cows is not included in this table, as it is figured that the value of the calves will exceed the interest and depreciation. It is figured that the income from bull services off-

side of the herd is sufficient to pay his feed cost. The following figures represent averages:

Average cost labor, etc., per cow for year	$35 19
Average cost labor, etc., per cow per day	.096
Average cost labor, etc., per quart milk	.029

Total Cost of Milk Based on Market Prices of All Feeds.

CALCULATION No. 1.

Cost of feed per cow per year	$95.24	
Cost of labor, bedding, stabling, etc., per cow per year	35 19	
Total		$130.43
Value milk per cow @ 5c per quart	$167.62	
Value manure per cow per year	15 00	
Total		$182 62
Total cost per cow for year		130.43
Total profit per cow for year		$52 19
Cost per cow per day for feed		$ .26
Cost per cow per day for labor, bedding, stabling, etc.		.096
Total cost per cow per day		.367
Value of milk per cow per day		.500
Profit per cow per day		142
Total cost per quart milk		0389

Total Cost of Milk Based on the Actual Cost of Roughage.

CALCULATION No. 2.

Cost of feed per cow per year	$66.55	
Cost of labor, bedding, stabling, etc., per cow per year	35 19	
Total		$101.74
Value of milk per cow @ 5c. per quart	$167.62	
Value of manure per cow	15 00	
Total		$182 62
Total cost per cow per year		101.74
Profit per cow for year		$80.88
Cost per cow per day for feed	$ .182	
Cost per cow per day for labor, bedding, stabling, etc	096	
Total cost per cow per day	.278	
Value of milk per cow per day	.500	
Profit per cow per day	221	
Total cost per quart milk	.030	

Feed Cost of Raising Calves.

Several calves and yearling heifers were included in the experiment, which is given previously in this report. The common practice in raising these calves has been to remove them from the dams within a few days after they were dropped and feed whole milk for three or four weeks, at which time they were changed to a skim-milk ration with what roughage and grain they would consume. The grain is not itemized in the record given, but for the most part the mixture was made up as follows: 2 parts Corn meal, 2 parts Beet pulp, 1 part Bran, ½ part Linseed Oil meal.

Practically no pasture has been available, and all calves under one year of age have been kept in pens in the barn nearly all of the time. During the last four months of the fiscal year they had access to a small exercise yard.

There is considerable variation in the average gain per day in different months. Especial attention is being paid, at the present time, to this point, which is being so emphatically brought out by the records. In the case of Kitty end, dropped May 8, 1913, in the month of January

the average gain per day was 2.51 pounds, in February 1.53, and in March a loss of .4 of a pound per day. In some cases this variation is due to a slight case of scours, but, after studying the matter closely, it was found that this was not wholly due to any apparent physical ailment of the calf.

Cases where the calves did not have a vigorous appetite, for even a few days during the month, seemed to have a marked effect upon the average gain in weight during that month. In order to keep a calf growing uniformly from one month to another, the utmost care should be taken to see that it does not receive an over-supply of food, for this seems to have as serious an effect upon the gains in weight as an insufficient amount.

During the present winter the majority of the calves under 12 months of age are being kept in an old stable which offers very little more protection than an open shed. Stanchions have been arranged in order that they may be fed individually, and at the present time, the gains in weight seem to be practically the same as when they were kept in more comfortable quarters.

Table No. 2 is a summary of the records of all calves, arranged by breeds. The averages per calf are given for the different breeds, showing the amount of feed fed to the average calf of each breed. The average age in months of the Holsteins was 7¾, and the feed cost for that breed was $29.73. Average gain per day was 1.03 pounds, and the average cost for one pound of grain $.124. The average age of the Jerseys was 11¼ months and the average cost of one pound of gain $.119. It should be remembered that the average cost of one pound of gain is less between 3 and 20 months of age than when the calf is under 3.

In some cases the calves have been kept on whole milk for a longer period, and a note made of the comparative gains in weight and costs per pound of gain on the whole milk as compared with skim-milk. This is true in the case of the Jersey calves as shown in Table No. 2. Daisy of Dunholm 2nd received only 240 pounds of whole milk and 1746 pounds of skim-milk. Her total gain in the 7 months was 193 pounds, while Princess Daisy of Oak Hill 2nd received 900 pounds of whole milk and 980 pounds of skim-milk during the 7 months, and gained only 144 pounds. The average cost of one pound of gain where the majority of the milk fed was skim-milk was $.094 per pound and where 900 pounds of whole milk was fed the cost was $.192.

In estimating the cost of feed fed calves, whole milk is figured at $.05 per quart, and skim-milk $.50 per 100 quarts, and grain and hay at market prices of feeds, as given in the report of the Station Dairy Herd.

Table No. 2.

Summary of the Feed Fed, Cost of Feed, and Gains in Weight for Holstein Calves.

NAME OF CALF.	Age in Months.	Whole Milk.	Skim Milk.	Hay.	Silage.	Green Feed.	Grain.	Cost of Milk.	Cost of Feed.	Total Cost.	Gain in Weight.	Avg. Gain Per Day.	Avg. Cost 1 lb. Gain.
Laura II.	7	342	1790	479	155	30	213	$12.48	$8.59	$21 07	259	1.23	.081
Sussex.	18	....	2048	1965 7	4130	725	1431	4.92	51.57	56.49	608	1 19	.076
Princess IV.	9	360	2470	581	238	.....	359 9	17 16	13.09	30.25	326	1.20	.093
Bess II.	5½	1025	980	243	31	.....	238	26 62	4.19	30 81	166	1.10	.185
Ethel II.	4	570	884	179	8	.....	116 2	16 22	3 51	19.73	118	98	.167
Netherland College.													
Duchess II.	5½	1082	868	212	28	.....	162.5	28 40	4 58	32 98	131	.79	.251
Molly II.	9	360	2470	506	380	330	312	17.16	11 83	28 99	246	.91	.117
Kitty II.	18	552	1196	1575	3044	1076	1104	17 07	43.37	60 44	526	1.03	.115
Maggie II.	20	720	2096	1965	4378	820	1655	22.19	56.57	78.76	753	1.56	.104
Princess 5th.	3	338	787	124	.....	....	39	9 81	1.82	11.63	60	.50	.193
Duchess 2nd.	3	252	1148	178	5	....	113	8 67	3 44	12.11	44	.48	.275
Trixie 2nd.	3	322	667	124	.....	....	37	9.17	1 77	10 94	28	.46	.390
Constance 2nd.	3	338	763	124	.....	....	37	9.63	1.77	11 40	59	98	.193
Beauty 2nd.	3	366	639	37	.....	....	19.5	10 16	60	10 76	23	.38	.467
Totals.	.....	6627	19106	8292.7	12397	2981	5890	$209.66	$206.60	$416 26	....	.....	......
Average per calf.	7¾	473 3	1364.8	592 3	885 5	212.9	420 7	$14 97	$14 76	$29.73	239	1.03	124

Summary of the Feed Fed, Cost of Feed, and Gains in Weight for Jersey Cows.

NAME OF CALF.	Age in Months.	Whole Milk.	Skim Milk.	Hay.	Silage.	Green Feed.	Grain.	Cost of Milk.	Cost of Feed.	Total Cost.	Gain in Weight.	Avg. Gain Per Day.	Avg. Cost 1 lb. Gain.
Manda.													
Marvel II.	17	156	1596	1714	3718 2	300	941.9	$7 56	$42 36	$49.92	450	1.07	.110
Daisy of Dunholm II.	7	240	1746	475	124	30	209	9 94	8 54	18.48	193	.91	.094
Mandy's College King.	17½	468	1596	1760	4145 5	202 5	1132	15.05	45.27	60 32	605 5	1.18	.099
Princess Daisy of Oak Hill II.	7	900	980	223	5	.....	125	23 68	4 07	27 75	144	.90	.192
Manda Matchless II.	18	300	21	597.9	1394.1	247 8	1121 8	12 21	44 13	56 34	452	.88	.124
Katherine 2nd	3	366	513	21	.....	.....	9.5	9 86	34	10.20	20	.33	.510
Totals.	....	2430	6451 7	4790 9	9386 7	780 3	3539.2	$78 30	$144 71	$223 01	.	.	.....
Average per calf.	11¼	405	1075 2	1124 6	1564 4	130	589 8	$13 05	$24.12	$37 17	311	92	.119

Summary of the Feed Fed, Cost of Feed, and Gains in Weight for Guernsey Calves.

NAME OF CALF.	Age in Months.	Whole Milk.	Skim Milk.	Hay.	Silage.	Green Feed.	Grain.	Cost of Milk.	Cost of Feed.	Total Cost.	Gain in Weight.	Avg. Gain Per Day.	Avg. Cost 1 lb. Gain.
Glencoe Maiden of P. 2nd.	4½	634	980	205	3	5	111.5	$17.36	$4.23	$21 59	116	.77	.186
Totals.	.....	634	980	205	3	5	111.5	$17 36	$4 23	$21 59	.	. .	.....
Average per calf.	4½	634	980	205	3	5	111 5	$17 36	$4.23	$21 59	116	.83	.186

Summary of the Feed Fed, Cost of Feed, and Gains in Weight for Ayrshire Calves.

NAME OF CALF.	Age in Months.	Whole Milk.	Skim Milk.	Hay.	Silage.	Green Feed.	Grain.	Cost of Milk.	Cost of Feed.	Total Cost.	Gain in Weight.	Avg. Gain Per Day.	Avg. Cost 1 lb. Gain.
Hannah Douglas II.	19½	648	2096	2065 5	4068	755	1428	$20 59	$53.01	$73 60	562	1 04	.130
Vona Skylands, No. 37637.	6	932	496	486	152	30	242	23 28	8 35	31.63	110	.66	.265
Mary Skylands, No. 37636.	6	972	496	422	32	110	242	24 28	7.76	32.04	115	.63	.278
College Scottie, No. 16796.	7½	572	1780	459	100	164	322	17 95	9.04	26 99	153	.72	176
Totals.	. .	3124	4868	3432.5	4352	1059	2234	$86.10	$78 16	$164 26	. .	. . .	......
Average per calf.	9½	781	1217	856.6	1088	214 7	558	$21 53	$19 54	$41 07	237	.83	.17

COW TESTING ASSOCIATIONS.

Two Cow Testing Associations, which were organized in 1913 for one year's work, have re-organized this year and begun their second year's work of record keeping.

The Sussex County Cow Testing Association held its annual meeting in June and elected the following officers: Pres., Winfield S. Phillips; Vice-Pres., Arthur Danks; Sec'y. and Treas., Thomas Inslee; Directors, the above officers and L. E. Savacool and Edward Ackerson. At the end of the first year, this Association lost only a few members, whose places have been taken by other dairymen. The Association has retained the services of Mr. Fred L. Champion, who was official tester for the first year.

The Passaic Valley Cow Testing Association has also re-organized for the second year's work and elected the following officers: Pres., D. A. Hopping; Vice-Pres., A. M. Webb; Sec'y. and Treas., C. E. Baldwin; Directors, the above officers and G. P. Squiers, H. R. Hopping, W. E. Baldwin and J. M. Hait.

Mr. Lindley G. Cook, a graduate of the New Jersey Agricultural College, is acting as official tester for this Association.

The Salem County Cow Testing Association was organized in May and the following officers elected: Pres., E. C. Moore; Vice-Pres., Frank Ridgeway; Sec'y. and Treas., A. B. Waddington; Directors, the above officers and Louis Edwards, Charles Richmond, Clem Richman and William Coles. This Association began work in July with approximately 520 cows. Mr. H. M. Allen, a graduate of the New Jersey Agricultural College, was engaged as official tester for the first year.

In order to encourage this work, the Dairy Department furnishes all necessary blanks for keeping the records, free of charge, and assists in the organization and supervision of the Associations. During the coming year this Department, in co-operation with the Extension Department, will be in a position to assist in the organization of several more Associations. If sufficient interest is manifested in the Association work by dairymen in one community, they should call a meeting of those interested and a representative of the Experiment Station will, upon request, attend such a meeting and explain in detail the Cow Testing Association work.

Records and Results of the First Year's Work in the Sussex County Cow Testing Association.

After completing the first year, this Association kindly furnished the Dairy Department with the records of production of all cows in the Association. A summary shows that the average number of cows in the Association for 12 months was 452.4. This was determined by adding the total number of months each cow was on record and dividing by 12. Cows that were in the Association less than four months were not included. The average production for all cows in the Association was 8,318 pounds milk, and 310.8 pounds butterfat. This is an exceptional

production for a Cow Testing Association, and is due to the fact that several of the herds are pure bred Holsteins in which some of the best individuals in the Country are represented. The remainder of the herds in the Association are high grade Holsteins, which are practically all sired by pure bred bulls.

Table in the Association one year 159a

Herd letter.	Average number cows.	PRODUCTIO Pounds milk.	Per cent. fat.	Pounds fat.	... hay.	Cotton seed meal.	D. Brewer's grains.	Gluten.	Beet pulp.	Molasses.	Cost of roughage.	Cost of grain.	Total cost feed.	Profit.
B	20.4	6256	3.9	246	$1 1	217	258	202	220	38	$27.99	$27.54	$55.53	$59.77
P	32.5	8833	3.8	342	1.	...	34	....	....	...	30.25	44.33	85.58	69.86
C	17.4	7462	3.7	276	14	..	..	680	227	69	31.66	35.25	66.91	73.27
E	50.0	7874	4 4	348	1	457	355	127	163	..	33.11	35.09	68.20	105.79
J	20.1	6712	4.2	285	1.	275	695	....	503	24	27.58	28 13	55.71	60 55
S	21.0	7008	3.3	237	1.	...	337	24	286	...	25 81	27.05	52.86	67.24
K	12.0	6978	3.6	265	1	182	815	....	257	...	26 18	32.69	58.87	71.50
O	22.1	8325	3.4	290	1.	...	...	605	287	39	21.83	32.61	53.94	85.72
L	18.1	8107	3.8	312	1.	...	29	426	426	...	31 95	49.05	81.00	72.00
F	23.1	7921	3.5	285	1.	171	230	128	....	...	27.87	33.07	60.94	81.46
N	31.0	8100	3.5	284	1.	274	827	301	177	...	31.73	29.87	61.60	73.32
I	21.0	7186	3.5	253	1.	...	171	....	....	..	32.69	21.84	54.53	68.30
A	20.7	10865	3.6	393	1	106	921	695	234	15	28.22	52.78	81.00	107.39
R	34.6	8924	3.6	323	1.	378	632	....	91	...	33.79	33.53	67.32	85.60
D	48.5	9854	3.3	333	1.	164	...	73	....	...	34.30	42.31	76.61	80 06
G	18.9	9902	3.7	376	1.	238	836	....	247	54	34.23	35.13	69.36	114.40
M	27.4	10431	3.1	331	1.	...	...	1075	1437	...	32.50	46.58	79.08	100.88
H	13.6	7279	3.9	287	1.	235	295	....	....	..	27.69	32.27	59.96	79.83

COW TESTING ASSOCIATIONS.

Two Cow Testing Associations, which were organized in 1913 for one year's work, have re-organized this year and begun their second year's work of record keeping.

The Sussex County Cow Testing Association held its annual meeting in June and elected the following officers: Pres. Winfield S. Phillips;

production for a Cow Testing Association, and is due to the fact that several of the herds are pure bred Holsteins in which some of the best individuals in the Country are represented. The remainder of the herds in the Association are high grade Holsteins, which are practically all sired by pure bred bulls.

The average milk production was as follows: 3 herds between 6,000 and 7,000 pounds, 6 herds between 7,000 and 8,000 pounds, 5 herds between 8,000 and 9,000 pounds, 2 herds between 9,000 and 10,000 pounds, 2 herds between 10,000 and 11,000 pounds.

It is not necessary to state that this is an exceptionally good dairy section, and that the herds are managed by intelligent dairymen. All dairymen in this Association, except three, have silos and have fed a comparatively large amount of silage during the year. Of the three that did not have silos, it will be seen that two fed succulent feed in the form of roots.

The prices at which feed is figured in estimating the cost of feed are the market values upon the farm, and as the community in which this Association is located is a considerable distance from any large market, the prices at which feeds are figured may be somewhat lower than in other sections of the State. This is true only of the roughage feeds grown on the farms. The concentrated grains are figured at practically the same value as would be the case in any other sections of the State. The price of hay ranged between $14.00 and $20.00 per ton; corn stover, $5.00 to $8.00; and silage $2.50 to $4.00.

Another point which should be mentioned in connection with the comparatively low cost of feed, is the excellent pastures in this section, and the number of days each herd averaged to be on pasture. It will be seen in looking over Table No. 2 that all herds, except one, received pasture, the average number of days for the whole Association being 138. Pasture was figured from $1.00 to $1.50 per month, depending upon the amount of feed available. The price received for milk was reasonably uniform throughout the whole Association.

Table No. 2 shows the production, cost of feed, and profit of the 10 best cows in the Association. Cow No. 45 in Herd D did not enter the Association until two months after it had started, and therefore has only a 10 months' record. In the 10 months she produced more than any other cow in the Association for the year. A study of this table shows that only four of the cows appearing in the column giving the 10 cows with the largest milk production, appear among the 10 cows with the largest profit over feed cost. This is probably accounted for by the fact that several of the cows producing the largest milk production were on advanced registry test and for that reason, the cost of feed is more than is the case where the cows are fed for the maximum amount of profit. This impresses upon one the fact that it is not always the cow that produces the largest amount of milk that brings the greatest profit.

Table No. 2.
Milk Production and Profit of Cows.

Herd Letter and No. of Cow.	10 cows with largest milk production			Herd Letter and No. of Cow	10 cows with largest profit.		
	Milk	Cost of Feed.	Profit.		Milk.	Cost of Feed.	Profit.
*D-45	17836	$103.44	$221 82	*D-45	17836	$103.44	$221.82
O- 4	15801	105.28	136.22	P-17	12039	53 63	168 04
B- 1	13710	105 70	125 07	D-10	12253	61.67	158 17
G-11	13625	88 66	146.90	G 11	13625	88 66	146 90
D-25	13546	89 08	142 47	D- 3	12547	64.59	146 08
D-28	13344	91.97	131 68	D-25	13546	89.08	142.47
O-10	13273	93.47	97.27	D-44	11950	82 55	138.08
M-15	13272	88.27	135 71	J-20	11097	64.69	138.42
Q-20	12969	83.73	137.19	Q-20	12969	83 73	137.19
M- 3	12954	83 78	136.37	P-22	10222	52 87	136 89
	140330	$933 38	$1410.70		128084	$744.91	$1534 66

*10 months' record.

In Table No. 3 the milk production, cost of feed, and profit, is given for the 10 cows producing the least milk and also for the 10 cows producing the least amount of profit. This data also shows that the cost of feed does not bear any more uniform relation to the milk production than in the case of the 10 best cows in the Association. It is found that only five cows appearing among the 10 lowest producers are included in the 10 which pay the least profit.

In this table is given the milk production, cost of feed, and profit for the 10 best cows and the 10 poorest cows.

Table No. 3.
Production, Feed Cost and Profit of the 10 Cows Producing the Least Milk and the 10 Making the Least Profit.

Herd Letter and No. of Cow.	Milk.	Cost of Feed.	Profit.	Herd Letter and No. of Cow.	Milk.	Cost of Feed.	Profit.
P- 2	2962	$45 99	$12.08	P- 2	2962	$45.99	$12.08
P-15	2090	44.21	17.42	O-15	6713	....	12.62
E- 4	3126	41.38	13.25	E- 4	3126	44.38	13.25
E-10	3328	43.93	16.73	J-11	4599	....	13 28
E- 8	3475	47.39	27.62	C-10	3487	56.77	13.31
C-10	3487	56.77	13.31	F-16	3935	53.00	16.24
A- 3	3929	53.02	23.04	E-10	3328	43.93	16 73
F-16	3935	53 00	16.24	E- 8	3475	....	27.62
E- 3	4243	42.61	30.97	B-19	5609	....	27.72
R-12	4260	37.14	50.87	O-22	5707	....	29.04
	34835	$465.44	$221.53	....	42941	....	$181.89
10 best cows	140330	$933.32	$1410.70	....	140330	....	$1410.70
10 poorest cows	34845	465 44	221.53	....	42941	....	181.89
Difference	105485	*467.88	1189.17	....	97389	....	1228 81

Table No. 4 offers an interesting study of the relation of the amount of feed fed, and cost of feed, to the milk produced. These figures are taken from the average yearly record of each herd. It should be remembered, in connection with these data, that all herds in the Association

were in pasture from 110 to 220 days, as given in the table. The feed received in pasture is not considered in giving the pounds of milk produced for each pound of feed fed.

The amount of grain fed in the different herds offers an interesting study. It will be seen that in most herds one pound of grain was fed for between three and four pounds of milk produced. However, there are several herds in the Association that fed one pound of grain for approximately 1.7 pounds of milk. This, in each case, does not mean that the cow received an over-supply of feed, for we find that the cows received only a very small amount of hay, and in another case, the cows received no silage at all. The per cent. of feed cost spent for grain, as represented for each herd, in one column of this table, varies from 40% to 50%.

Table No. 4.

Relation of Dry Matter Fed to Milk Production.

Herd.	Lbs. milk.	Profit over feed.	Lbs. dry matter in roughage.	Lbs. dry matter in grain.	Total lbs. dry matter.	LBS. MILK PRODUCED FOR EACH LB. DRY MATTER FED.		
						In roughage	*In grain.*	*Total feed.*
B.	6256	$59.77	3336	1669	5005	1.8	3.8	1.2
P.	8833	69.86	4093	2389	6482	2.1	3.7	1.3
C.	7462	73.27	4146	2261	6407	1.7	3.3	1.1
E.	7874	105.79	3406	3077	6483	2.3	2.5	1.2
J.	6712	60.55	2663	1708	4371	2.5	3.9	1.5
S.	7008	67.24	2772	2458	5230	2.5	2.8	1.3
K.	6978	71.50	2518	1974	4492	2.8	3.5	1.5
O.	8325	85.72	2354	4267	6621	3.5	1.9	1.2
L.	8107	72.00	2871	2915	5786	2.8	2.7	1.4
F.	7927	81.46	2455	3142	5597	3.2	2.5	1.4
N.	8100	73.32	3712	1902	5614	2.1	4.2	1.4
I.	7186	68.30	2788	2793	5581	2.5	2.5	1.2
A.	10865	107.39	3065	5026	8091	3.5	2.1	1.3
R.	8924	85.60	4730	1946	6676	1.8	2.6	1.3
D.	9854	80.06	3220	2376	5596	3.0	4.1	1.7
G.	9902	114.40	3108	5735	8843	3.1	1.7	1.1
M.	10431	100.88	3705	2982	6687	2.7	3.5	1.5
H.	7279	79.83	2827	2230	5057	2.5	3.2	1.4

The information given in the above table should be considered with that which is given in Table 5. This gives the relation of dry matter fed to the milk produced, and profit over feed. The average pounds of milk produced in the different herds for one pound of dry matter fed is remarkably uniform throughout the whole Association. However, we find considerable variation when a study is made of the milk produced for each pound of dry matter fed in the roughage, as compared with the grain.

Herd E appears with an average milk production of 7874 pounds milk and an average profit over feed cost of $105.79, and there was 1.2 pounds of milk produced for each pound of dry matter fed in the total feed. The same is shown in the case of Herd O. When the roughage and grain are considered separately, we find that in Herd E 2.3 pounds were produced for each pound of dry matter fed in the roughage, and 2.5 pounds of milk for each pound of dry matter fed in the grain. In

Herd O, which has an average production of 8325 and a profit over feed cost of only $85.72, we find that there was 3.5 pounds of milk produced for each pound of dry matter fed in the roughage, and 1.9 for each pound fed in the grain. This illustrates the point that although the cows in each herd received the same amount of dry matter for each pound of milk produced, yet the herd that received the greater amount of roughage feed and the smaller amount of grain, paid a much greater profit in proportion to the milk produced. A study of this table seems to point out the following facts:

1. When silage is used in the roughage ration, the greatest profit over feed cost in proportion to the amount of milk produced is received when practically the same amount of dry matter is fed in the roughage feed as is fed in the grain, and where one pound of dry matter is fed in the total feed for approximately 1.2 pounds of milk produced.

2. When the pounds of milk produced for each pound of dry matter fed in rhe roughage exceeds 3 pounds, and the pounds of milk produced for each pound of dry matter fed in the grain is helow 2 pounds, the profit over feed cost is considerably less in proportion to the milk produced.

3. When the pounds of milk exceed 4 for each pound of dry matter fed in the grain and are below 2.5 for each pound of dry matter fed in the roughage, there is also a decrease in the profit in proportion to the amount of milk produced.

Table No. 5.

Relation of the Amount of Feed Fed and Cost of Feed to the Milk Produced and the Value of Milk in Each Herd.

HERD LETTER.	Days in pasture.	LBS. MILK PRODUCED FOR EACH LB. OF FEED FED.					Per cent. of Total Value Spent for feed.	Per cent. of Feed Cost Spent for Grain.	Average Profit Over Feed Cost.
		Cured rough-age.	Silage.	Soiling crops.	Roots	Grain.			
B.	114	4.3	1.1	4.5	......	3.3	48	49	$59 77
P	......	6.1	.8	......	....	3.2	55	51	69.86
C.	136	3 7	1.2	4 7	...	2.9	47	52	73.27
E	110	5.2	1.0	24.3	....	2 2	39	51	105.79
J.	167	7.2	1.1	11 3	....	3 4	47	50	60.55
S.	142	3 6	1.5	.	....	2 5	44	51	67.24
K.	154	3 7	1.9	....	....	3.1	45	55	71.50
O.	146	3 2	....	.....	5.8	1 7	38	60	85.72
L.	155	4 5	1.5	...	....	2 4	52	60	72.00
F.	178	6.2	1 4	.....	......	2.2	42	54	81.46
N.	171	14.3	1.05	4.1	3.6	3.7	45	48	73.32
I.	183	4.7	1 2	.. .	....	2 2	44	• 40	68.30
A.	116	12.1	1.2	......	......	1 9	42	65	107.39
R.	130	6.05	1.4	25.7	.....	4 0	44	49	85.60
D	147	6.9	1.5	21.4	12.7	4 1	48	55	80 06
G.	220	5 1	1 7	......	.....	1.5	37	50	114.40
M	148	2 8	....	9 2	14.3	3 07	43	56	100.88
H.	150	3 49	1 8	.....	......	2.3	42	53	79.83

General.

The Dairy Department feels that there is no line of extension work that can do more to advance the dairy industry of the State than the organization of Cow Testing Associations in communities where there

is sufficient interest and the necessary number of cows to warrant the organization.

The actual work of keeping records and the assistance of the official tester places before each dairyman valuable information regarding his individual cows, and also stimulates a deeper interest in dairying and a desire to own a better herd and feed and care for it intelligently. Aside from this, the educational feature of the work is of considerable importance and offers one of the most efficient forms of dairy organization.

The Dairy Department of the Experiment Station, in co-operation with the Extension Department, is in a position to assist in the organization of several more Associations. Full details regarding the organization and plan of work may be obtained upon application to this Department. Blanks for keeping records are furnished free of charge to Associations, and assistance will be given in the supervision of the Association after it has been organized.

Advanced Registry Work.

The total amount of advanced registry work done by breeders in New Jersey has increased during the last few years. The work, as reported in the last Annual Report of the Experiment Station, has been conducted with six breeds as follows:

Holstein
Guernsey
Jersey
Ayrshire
Dutch Belted
Brown Swiss.

The number of tests supervised during the fiscal year as given below:

Holstein Friesian	
4 semi-official tests	
217—7 day tests	
3—14 day tests	
37—30 day tests	
Guernsey	653-2 day tests
Jersey	146—2 day tests
Ayrshire	172—2 day tests
Dutch Belted	53—2 day tests
Brown Swiss	25—2 day tests

This shows a slight decrease in the amount of Guernsey work and an increase from 175—7 day tests with Holsteins in the fiscal year 1912-13 to 217—7 day tests during the past fiscal year.

Records of feed fed have been carefully kept during the past year, as well as records of the milk and butterfat production.

When a sufficient amount of this data is accumulated a study of the relation of feed fed to milk production under advanced registry conditions will furnish information of considerable importance, and it is hoped that after another year's records have been accumulated, sufficient data will be available to give some important information along this line.

COST OF PRODUCTION.

In order to give approximate figures of costs of production and e-turns over feed cost on dvanced registry tests, this data includes the value of milk produced by each row at both four and five cents per quart. The feeds are given a value and the total cost of feed estimated on this basis.

In computing this data feeds are figured as follows:

Pasture	$1 00 per month
All Hay	20.00 per ton
Ensilage	4 00 per ton
Corn Stover	8 00 per ton
Corn Fodder	8 00 per ton
Roots	6 00 per ton
Soiling Crops	4 00 per ton
Grain	30 00 per ton
Molasses	20.00 per ton.

Method of Estimating Production.

The production recorded in the accompanying tables is estimated for all yearly tests including Guernsey, Jersey, Ayrshire, Dutch Belted and Brown Swiss and semi-official records of Holsteins. The yield during the two days each herd is visited by the supervisor is used as a basis for estimating the total production. In the case of Holstein official tests, which include the 7, 14, and 30 day tests, the actual production is given.

A summary of the average production per cow for 12 months is given in Table No. 6 for each breed. This also includes the costs of production, and the profit over feed cost, when milk is figured at $.04 and $.05 per quart.

The average milk production for the Guernseys and Jerseys is some less than that of the Ayrshires, yet on account of the high butterfat test, the total amount of fat produced is nearly as much as that of the Ayrshires, and, if the value of the product was figured on a butterfat basis, the relative profit of the Guernseys and Jerseys would be greater.

It should be understood that a comparison of the different breeds can not be made from the records as they have been compiled on account of the fact that the data does not include a large enough number of cows of the Dutch Belted, Brown Swiss, Ayrshire and Jersey breeds. However, the relation of the milk produced to the cost of feed offers a most interesting study, and the records point to the fact that the Guernseys, Jerseys and Dutch Belted are fed very economically, considering that they were on advanced registry test.

Table No. 1.

Record Production, Feed Cost and Profit

Breed.	Milk.	% Fat.	Lbs. Fat.	Value of milk @ 4c per qt.	Value of Milk @ 5c per qt.	Cost of roughage.	Cost of grain.	Total cost of feed.	Profit @ 4c.	Profit @ 5c.
Guernsey. .	7172.1	5.1	366.46	$143 22	$179 00	$38 66	$64.48	$103.14	$41.94	$75.65
Jersey. . . .	7036.6	5 4	382.27	138.13	172.66	26.26	51.51	77.14	60.34	94.80
Ayrshire. . .	10165.1	3.9	405.20	305 91	384.61	61.77	122.56	184.33	121.58	200.28
Dutch Belted. . .	13106.5	3 6	472.50	253.47	312.04	40.72	64.75	105.47	148.00	206.57
Brown Swiss. . . .	7069 8	4.2	336.30	151.79	189.74	69.62	61.51	131.13	20.66	58.61

Table No. 2—Summaries of Holstein 7 day Records Giving Production and Costs of Production.

Herd letter.	Number of cows.	Milk produced.	Per cent fat.	Pounds fat.	Value of milk @ 4c. per quart.	Value of milk @ 5c. per quart.	Days pasture.	Silage.	Hay.	Corn stover.	Soiling crops.	Roots.	Grain.	Cost of roughage.	Cost of grain.	Total cost of feed.	Profit @ 4c.	Profit @ 5c.
A.......	2	952.0	4.0	38.7	$18.12	$22.65	....	......	83	......	....	524	257	$1.65	$3.85	$5.50	$12.62	$17 15
B.......	18	7375.7	3.2	237.02	144.82	180.37	....	......	2766	1140	....	4095	2472	44.50	37.08	81 58	63 24	98 79
C.......	16	6195.0	3.8	236.01	118.00	147.50	....	875	1106	.....	1750	406	......	17.53	28.16	45.69	72.31	101.81
D.......	13	5736.8	3.6	207.43	109.27	136.59	....	3464	728	.....	803	4061	6391	27.99	17 52	45.51	63.76	91.08
E.......	5	2127.4	3.0	64.64	40 52	50 65	....	1050	490	.....	....	......	558	7 00	8.37	15.37	25.15	35.28
F.......	2	842.8	3.4	28.97	16 05	20.06	....	......	112	140	....	......	223	1.68	6.70	8.38	7.67	11.68
G.......	3	*1462.2*	*2.8*	*42.50*	*27 84*	*34.81*	21	......	294	.....	630	......	431	7.20	6.45	13.65	14.19	21.16
H.......	24	10497.6	3.7	403.76	199.94	249.93	....	1680	2240	.....	....	665	......	27 46	60.80	88.26	111.68	161.67
I.......	6	2503.1	3.8	96.27	47.67	49.59	....	612	168	.....	....	......	875	2.91	13 12	16 03	31.64	33.56
J.......	6	2005.1	3.3	67.86	38.19	47.73	....	840	350	.....	....	......	877	5.18	13.15	18 33	19 86	29.40
K.......	5	1951 0	3.4	65.50	37.16	48.45	....	520	138	.....	....	1300	351	5 19	5.25	10.44	26.72	38 01
L.......	4	1361.8	3.4	47.64	25 93	32.42	....	1120	....	.....	....	......	644	2.24	9.66	11.90	14 03	20 52
M.......	1	291.2	2.9	8.52	5.54	6.93	....	......	105	.....	....	......	118	1.05	1.77	2.82	2 72	4.11
N.......	2	846.8	3.4	29.21	16.12	20.16	....	......	....	.....	140	......	727	.28	10.89	11.17	4.95	8.99
O.......	5	*2036.8*	*3.6*	*73.63*	*38.79*	*48.49*	....	......	392	.....	....	......	978	3.92	14.66	18 58	20 21	29.91
P.......	17	7482.0	3.9	299.17	142.48	178.14	14	2465	902	.....	....	5450	2717	27.80	44.35	72.15	70.33	*105.99*
Q.......	6	1692.7	4.0	68.39	32.24	40.30	....	......	448	.....	....	......	1257	4.88	18.84	23.72	8.52	16.58
R.......	12	5120.8	3.5	180.10	97.53	121.92	....	1050	1120	.....	....	2394	2647	20 48	41.42	61.90	35 63	60.02
S.......	3	1249.4	3.4	42.79	23.79	29.74	....	280	200	.....	....	630	583	4 45	9.07	13.52	10.27	16.22
T.......	12	5701.9	3.7	212.60	104.79	130.99	....	1295	1260	.....	420	2114	2053	23 37	30.80	54.17	50 62	76 82
U.......	14	6693.6	3.1	210.55	126.48	149 36	....	840	1540	.....	840	......	2098	18.76	30 86	49.62	76.86	99.74
V.......	5	1912.2	3.5	68.55	36.42	45.52	....	980	427	.....	....	......	1956	6.23	29 34	35 57	.85	9.95
W.......	9	4170.9	4.2	179.10	79.24	99.30	....	840	500	.....	....	6800	1526	27.08	22 89	49.97	29 27	49.33
X.......	22	9577.0	3.3	321.62	182.41	248 01	62	3488	2256	.....	....	3516	4946	34 09	87 40	*121 49*	*60 92*	*126 52*
Y.......	5	1789.0	3.2	68.43	34.08	42.60	....	......	350	.....	....	......	803	3.50	12.04	15.54	18 54	27.06
Totals..	...	91574.7	3.6	3208.96	$1,743.42	$2,182.21	97	21399	17975	1280	4583	31955	35488	326.42	564.44	890.86	852 56	$1,291 35
Aver. per cow for *7 days*..	...	422.0	3.6	15 20	8.03	10 06	4	98.6	82 8	5 8	21.1	147 2	162.1	1 51	2 60	4 11	3 93	5 95

A most important feature of a summary which gives the average per cow of all cows tested, is the fact that the average cost of feed for a 7-day record was $4.11, the cost of roughage being $1.51 and grain $2.60 for the 7 days, and the average value of milk produced, at $.04 per quart, was $8.03. In this case, the feed cost to produce this amount of milk is slightly above 50% of the value of the product; therefore, the relation of the cost of feed to the total value of the product is practically the same in the case of the average record of the 7-day tests, as we find it in the yearly records of cows, which are considered to be economically fed.

Where the production, and cost of production are given for 30 days, we find that the average cost of feed for the 30 days is $15.92, while the average value at $.04 per quart is $39.47. In this case, the cost of feed is less than 50% of the value of the product.

It is usually considered that when the feed cost is not above 50% of the value at $.04 per quart, the cow is being economically fed. It should be borne in mind that the averages for a 30-day period would show a more favorable result than the total of a lactation period or a fiscal year's record. However, it seems that as the records accumulate, the cows on advanced registry test are being much more economically fed than is generally supposed.

The following figures represent the average amount of feed consumed *per cow for one year by the different breeds:*

	Pasture (days).	Silage	Hay.	Corn stover.	Soiling crops.	Roots.	Grain.
Guernsey*......	76	4620	2382	32	660	1098	4289
Jersey....	105	7036	718	620	419	....	3434
Ayrshire†	104	438	4713	....	215	792	7981
Dutch Belted.....	153	3766	2367	...	1850	...	4002
Brown Swiss......	...	8042	3519	285	1860	357	4100

* 4 molasses. †60 molasses.

The *cost of this feed* per *cow for one year, based upon prices given* previously in this report, are as follows: Guernsey, $103.14; Jersey, $77.77; Ayrshire, $184.33; Dutch Belted, $105.40; Brown Swiss, $131.13.

Rules and Regulations Governing Tests.

During the past fiscal year a circular has been issued, giving the rules and regulations governing the conduct of advanced registry tests in New Jersey. Several improvements have been made in the manner in which the advanced registry tests are supervised. During part of the fiscal year, Mr. Edward Grombacher served as inspector of the work of supervisors, and through his reports this Department has kept in much closer touch with the actual work of the supervisors.

It has been impossible to test all of the composite samples submitted to the Station except during the time Mr. Grombacher acted as inspector, and these samples were tested by him either at the time he visited

each dairy or upon his return to the Experiment Station. It is impossible to handle this work properly during the winter months without assistance of an inspector of supervisors. The income from the advanced registry work done is not sufficient to meet such an expense, as it covers only the incidental office expenses.

Advanced registry testing should be done by every dairyman who owns a pure bred cow capable of meeting the requirements. There is no question but what it is a good business investment to spend the money necessary in making an advanced registry test.

Information regarding the conduct of these tests will be gladly furnished upon application to this Department.

Report of the Seed Analyst.

JOHN P. HELYAR, ANALYST.
ROBERT SCHMIDT, ASSISTANT.

During the second year of the existence of the State Seed Laboratory the work has been extended along lines similar to those of the preceding year. In the year there has been a notable increase in the demands for service from residents of the State. This fact is accepted as an indication that more people have become acquainted with the existence of the Seed Laboratory and that possibly, because of its efforts, more people are coming to recognize the need of accurate seed information when making purchase.

Number of Samples Tested.

A larger number of official samples has been collected in the various local markets, the analyses of which will give a wider knowledge of the quality of seed actually being offered for sale in the State. It is also possible that some of the results will be a strong argument for more careful attention on the part of the farmer and others in the matter of seed purchase.

As before in the inspection work greater stress has been placed with the field crop seeds including in those the several species of grass and clover seeds generally sown in the State. It is evident from the unofficial samples received that information is desired with respect to this class of seeds. A comparison of the year's work with that of the previous year is indicated below.

Number of samples tested in 1913: Offical, 221; unofficial 265; total, 486. Number of samples tested in 1914: Official, 455; unofficial, 443; total 898. Increase in 1914: Official, 234; *unofficial 178; total, 412. Per cent. increase over 1913: Offical, 105; unofficial, 67;* total, 85.

Lawn Grass Mixtures.

Special attention has been given to the composition of mixtures offered to the public for the purpose of seeding lawns. A number of such mixtures have been purchased in open market and tested in the laboratory. It is believed that the publication of the results of such tests in connection with information concerning the making and care of lawns will be of value to residents of the State.

Publications.

During the year a bulletin has been issued giving the results of the inspection in 1913, together with information as to the functions of the Seed Laboratory and also as to the proper methods of securing and submitting samples for testing. A bulletin giving the results of the present year's inspection is in preparation and will be published in the near future. Items of interest and importance to the seed buyer have been

submitted to the press for general distribution in the publications of the State.

Extension.

The laboratory has continued in its attempts to reach the farmer through the medium of the farmers' institute, the Grange, the press and also by personal visitation of the analyst where necessary. Advise has been given as to methods of buying with a view to getting the quality desired at a commensurate price. The general merchant of the smaller towns who is usually the local seed dealer has been invited to make use of the Seed Laboratory as a means of securing information that will be of service in securing seeds of quality for his patrons.

Several incidents have served to emphasize to some individuals and to some communities the value of having some definite information from a reliable source as to the quality of seed they are intending to buy or sow. Such incidents have been rather expensive and therefore effective lessons to the parties concerned. It is believed that the publication of the facts will be of value in emphasizing to others the possible dangers in blind procedure in seed buying.

Weeds.

Owing to the close relation of seeds and weed introduction and dissemination the analyst has undertaken the identification of weed plants submitted to the Experiment Station and where desired has suggested methods of eradication. Many requests have been received for information relative to feasible methods of eradicating Canada thistle (Cirsium arvense (1.) (Scop.). This very obnoxious weed seems to be gaining a strong foothold in the State and bids fair to become a more serious pest in the future if steps are not taken now to destroy it where it has already become established, and to prevent its introduction in seed and through other channels.

From the southern section of the State have come several complaints about horse nettle (Solanum carolinense L.). This weed grows in a manner similar to Canada thistle and apparently in some instances becomes as serious a pest as the latter. Apparently this weed is being introduced into some sections in commercial seed.

Another weed plant which has caused considerable trouble and loss in some sections of the State is one known as knawel, (Scleranthus Annuus L.). Like the chickweeds this plant thrives in the autumn and in several instances has been reported as being so aggressive as to crowd out alfalfa and grass on new seeded land. To find a possible means of combatting this weed the following treatment has been advised in the case of four plots of about one-fourth acre each on the farm of Mr. P. S. Straus at Red Bank.

Plot 1. Plow to the regular depth of plowing as early as the soil will permit; prepare the seed bed and plant spring rye, seeding at the rate of two bushels per acre. Two or three hundred pounds of fertilizer, 2-8-10, should be applied at the time of sowing. Allow the rye to grow until

the latter part of June then turn under and plant buckwheat. Plow buckwheat under the latter part of the season, fallow the field for three weeks and then plant to winter rye.

Plot 2. To be treated in a manner similar to plot 1 except that an application of manure at the rate of fifteen tons per acre should precede first planting with rye in the spring. Preferable to work in manure after plowing.

Plot 3. Treated as plot 1 and 2 in matter of plowing. Fallowed until the middle of June and then planted to cowpeas.

Plot 4. Treated as plot 3 except that plowing should exceed usual depth as much as possible.

On the land included in these plots it has been practically impossible to establish alfalfa or grass. This condition may in part be due to climatic conditions which apparently have favored the knawel and therefore given it great advantage over the seedlings of the crop sown. In the treatments suggested for the first three plots it is expected that the organic matter added will give grass or alfalfa an advantage that they otherwise lack because of the rate at which this is removed from the very light soils involved. The fallowing will also tend to promote the germination and destruction of such seeds as are in the soil. In plot IV the deep plowing is intended to place the weed seeds so low in the soil that they will not give further trouble.

Projected Work.

The Seed Laboratories of some states have issued to the public, at cost, sets of weed seeds made up in convenient size and form for careful inspection. These have been purchased by schools, farmers, and seedsmen and furnish to the holder a means of identifying common weed seeds by reference to these standard samples. The analyst believes that such sets have many possibilities and is making plans for introducing similar ones into this State. It is thought desirable to precede the weed seeds with samples of the most common of the grass and clover seeds used in this section. In this samples of the highest quality will be used and thus furnish to the buyer a grade which he will possibly try to duplicate in purchase.

To those who are engaged in seed analytical work it is evident that the best results are going to ensue when it will be possible to establish standard methods of analysis. To arrive at this will involve considerable experimental work. It is hoped that time and funds will permit this laboratory to give attention to some of the problems involved. At present the lack of uniform methods and in many instances the lack of adequate training and equipment place the analysts in a difficult position with reference to the enforcement of seed laws in the various states.

Needs of the Department.

With the increase in samples for analysis and the development of other worthy lines of work there must come an increase in the laboratory force. Such increase will necessarily demand larger funds and it

is suggested that the annual appropriation for this department be increased to $3,000. That will enable the laboratory to give prompt service at seeding time when the demands are greatest and also make it possible to develop the other work mentioned.

Agricultural Extension.

Report of Division of Extension in Agriculture and Home Economics for the year ending October 31, 1914.

BY ALVA AGEE, DIRECTOR.

"The extension work of an educational institution embraces all of its activities for the instruction of people who are not resident at the institution." This is a definition of extension work that has been accepted by the national association of agricultural colleges and experiment stations. Our educational and research institutions in the various states have found it necessary throughout their existence to engage in some extension activities. This has been due in part to the necessity of popularizing their endeavor so that financial and moral support might be secured and held, and in recent years it has been due in higher degree to insistent demand upon the part of the people that helpful information be given them. The New Jersey Experiment Stations, through their various departments, became engaged in a large amount of practical demonstration and instruction throughout the State in an early day. A Department of Agricultural Extension was created December 1, 1912, in order that the work might be prosecuted more vigorously and research departments might be relieved in large degree of the distractions to their work that necessarily attend extension activity. There was no effort to place all outside work within the new department because the members of the instructional and research staffs were in such close relations with the people of the State that the best service could not be assured through its interruption. The aim of the new department was to assist every department of research in reaching the public by increased facilities and to relieve the department in so far as organization and a new staff of specialists could do so. It is proper to express here the department's appreciation of the spirit of hearty co-operation that has been found in the entire College and Station staff.

Organization.

Effective work can result only from sound organization. The principle has been recognized that there may not be two sources of authority within one institution in respect to the character of instruction given along any one line. The extension department, through its specialists, meets the people of the State, and it is necessary that it carry to them the accepted views of the institution. The rule, therefore, has been laid down that, while the director of extension controls the time of the members of his staff, the instruction given by any specialist is under the supervision of the department within the College and Station that has that

subject in hand. The specialist in any subject needs close association with the men within such department, and whenever his duties throughout the State do not demand his time he may be assigned work by the department having his speciality in charge. This close association is beneficial to the man and to his institution and to the people of the State.

National legislation involving heavy appropriations of National funds to the various states made necessary the creation of a Division of Extension in Agriculture and Home Economics within the State Agricultural College, and such a division was formed July 1, 1914. The work of the Department of Agricultural Extension in the New Jersey State Experiment Station was so co-ordinated with the work within the new division that a report of extension activity necessarily embraces this co-ordinated work as a whole.

The Smith-Lever Act.

An act of Congress, known as the Smith-Lever act and receiving the approval of the President May 8, 1914, was the response of the National Government to a widespread demand for extension work in agriculture and home economics throughout the country.

The purpose of the Smith-Lever act is "to aid in diffusing among the people of the United States useful and practical information on subjects relating to agriculture and home economics, and to encourage the application of same." It provides for extension work to be inaugurated in connection with the land-grant colleges of the states and to be carried on in co-operation with the United States Department of Agriculture. "That co-operative agricultural extension work shall consist of the giving of instruction and practical demonstrations in agriculture and home economics to persons not attending or resident in said colleges in the several communities, and imparting to such persons information on said subjects through field demonstrations, publications, and otherwise; and this work shall be carried on in such manner as may be mutually agreed upon by the Secretary of Agriculture and the State Agricultural College or colleges receiving the benefits of this act."

"That for the purpose of paying the expenses of said co-operative agricultural extension work and the necessary printing and distributing of information in connection with the same there is permanently appropriated, out of any money in the treasury not otherwise appropriated, the sum of $480,000 for each year, $10,000 of which shall be paid annually in the manner hereinafter provided, to each State which shall by action of its legislature assent to the provisions of this act."

The act further appropriates for the benefit of all the states "an additional sum of $600,000 for the fiscal year following that in which the foregoing appropriation first becomes available and for each year thereafter for seven years a sum exceeding by $500,000 the sum appropriated for each preceding year, and for each year thereafter there is permanently appropriated for each year the sum of $4,100,000 in addition to the sum of $480,000 hereinafter provided. Such additional sums shall be used only for the purposes hereinbefore stated and shall be allotted annually to

each state by the secretary of agriculture and paid in the manner hereinbefore provided, in the proportion which the rural population of each state bears to the total rural population of all the states as determined by the next preceding federal census; provided further that no payment out of the additional appropriations herein provided shall be made in any year to any state until an equal sum has been appropriated for that year by the legislature of such state or provided by state, county, college, local authority or individual contribution from within the State, for the maintenance of the co-operative agricultural extension work provided for in this act."

The annual appropriation to the State of New Jersey through this act will become $62,000 seven years hence, provided an equal amount is available at that time from state, county and other sources. Beginning with $10,000 in the current year, the annual increase would be about $7,000.

Projects.

All of the work of the extension division is organized by projects, and all projects involving the expenditure of any Smith-Lever funds must have the approval of the States' Relations Service of the National Department of Agriculture. Eleven projects have been listed in the plan of work of the division.

Farm Demonstration.

One of the most important projects in our extension work is concerned with county farm demonstration. An act was passed by the New Jersey State Legislature in May 1913, providing for the appointment of a State Superintendent of Farm Demonstration.

"For the purpose of assisting the farmers of this State to care for and improve the conditions of the soil, to increase the productivity of the farms and the value of farm products, the State superintendent of farm demonstration, hereinafter provided for, is hereby authorized and directed to conduct a continuous course of demonstration of the most improved and scientific methods of agriculture in the various counties of this State, selecting for purposes of demonstration farms in the various counties of this State which are most convenient of access to the majority of the farmers of such counties, the owners of which consent thereto and agree to co-operate in such demonstration work. The demonstration work contemplated by this statute shall be performed by the owners of such farms under the direction of the state superintendent and the county superintendents, as hereinafter provided, and the farms upon which work is in progress shall be open to the inspection of all persons interested in such work, in order that the results thereof may be as clearly and widely observed as possible. * * * The Board of Managers of the New Jersey State Agricultural Experiment Station may appoint, whenever it seems necessary to them, for each of the counties in this State a county superintendent of farm demonstration, who shall be a man of practical

experience and who shall reside in the county for which he is chosen during his term of office and devote his time to the proper performance of his duties, which shall be the supervision and furtherance of farm demonstration work in his county, under the supervision and direction of the State superintendent. The county superintendent shall receive such salary as the State superintendent shall fix, said salary, or so much thereof as the State superintendent may require, to be paid by the county for which he is appointed, from money appropriated for that purpose by the county."

The present director of the extension division was appointed State Superintendent of Farm Demonstration by the Board of Managers of the State Experiment Station. It is his duty to carry on farm demonstration work throughout the entire State, but he has availed himself of the provision that county superintendents of farm demonstration might be appointed where the best interests of the public demanded such action. Work under this plan is entirely in line with the county plan which was inaugurated by the National Department of Agriculture several years ago, and is also in line with the thought of Congress in the enactment of the Smith-Lever bill, as shown by the discussions of Congress when the bill was before it. The county is usually the logical unit for extension work so far as local prohlems are concerned, and its best interests can be served through a representative of the State College and Experiment Station who may be known as a county extension representative or agent or farm demonstrator. It has thus come about that county farm demonstration could rightly be made a project within the scope of the Smith-Lever act, of the plans of the Bureau of Plant Industry in the National Department of Agriculture which has a special appropriation for such work of the farm demonstration law of New Jersey, and of the natural extension plans of the State agricultural institutions embracing county organization.

The State Superintendent of Farm Demonstration believes that the appointment of a county representative is inexpedient whenever a strong local demand for such appointment does not exist. There has been insistence that any county desiring such appointment should submit petitions bearing the names of a sufficient numher of progressive farmers and other business men to afford evidence that the demand is reasonably general, and that the new endeavor will have faithful local support. When such petitions have been received the State superintendent asks some of the farmers of the county to join him in meeting the board of chosen freeholders when a request is preferred for an appropriation to support the work. It is not within the duty of the State superintendent to do more than to present the whole matter, and in nearly every instance the boards of freeholders have cordially made the necessary appropriations for establishment of the work. The interests of the county require the appointment of a practical man who has had a sound training in agricultural science. His position becomes one of local leadership, although he regards himself only as the instrument through

which his State College and Experiment Station and leading people of the county who form his advisory board may work. The peculiar soil and climatic and market conditions of New Jersey have made the selection of such men difficult. The only test is efficiency, and no consideration of former residence or political or religious affiliation can enter to bar the appointment of the one person who may serve the rural interests of the county most efficiently. When such an one seems to have been found, he is recommended to the Board of Managers of the State Experiment Station, and his tenure in that position depends upon his ability to serve the agricultural and rural life interests of the public.

History of County Work.

Sussex county was the first county to be organized for local work within the state. The organization was effected March 16, 1912, by the Bureau of Plant Industry in the National Department of Agriculture, the county bureau plan being adopted. The work was supported by the Bureau of Plant Industry, the D. L. & W. railroad and voluntary subscriptions. H. W. Gilbertson was appointed county agent. July 21, 1913, the work was reorganized under the state law, Mr. Gilbertson being appointed county superintendent of farm demonstration. During the year just closed 1,596 individual letters and 5,106 circulars were sent out by him. There were 526 calls at his office. Three hundred and eighty-five farm visits were made and 60 addresses were given. Excellent service has been rendered through promotion of dairying, including the work of a cow-testing association, and demonstrations in the rational use of lime, commercial fertilizers, cover crops, legumes, pasture mixtures, better seed and in fruit-growing. Widespread interest in corn-growing and tomato-growing contests among young people has been aroused. Canning demonstrations have been specially helpful.

County bureau work in Mercer county was organized by the Bureau of Plant Industry November 1, 1912, and John H. Hankinson was appointed county agent. In the last year 1,500 individual letters and 3,000 circular letters have been sent out. The number of inquiries was 450, and 555 farm visits were made. Sixty-five meetings were addressed during the year, 3,000 people being present. Cover and green manure crops have received a great deal of attention this year, 90 demonstrations having been started last year. The acreage of cover crops has increased 20 per cent. and this is partly due to demonstration work. Demonstrations with fertilizer and lime have been made. A county potato association has been organized and various potato demonstrations have been conducted. A fruit-growers' organization was formed to improve methods of marketing. Orchard demonstrations were made. Considerable time was given to boys' and girls' club work. The second year of demonstration work in this county has been highly successful.

Appropriation was made by Monmouth county for the support of demonstration work and William B. Duryee, Jr., was appointed county superintendent of farm demonstration to take effect April 1, 1914. In the seven months that the work has been organized 1,705 letters of information and 453 circulars and bulletins have been sent out. The total number of farms visited is 370. The average number of farmers visiting the office for information has been 17 per month. Thirty-six press notices have been sent out. Twenty-six farmers are carrying on demonstrations with cover crops, and 11 are testing the value of alfalfa combined with one or more grasses. Variety tests with soybeans, alfalfa, and corn have been carried out. Attention has been given to orchard demonstrations. The co-operation with the rural Y. M. C. A. in agricultural contests is very close.

Appropriation by Bergen county for its work became effective April 9, 1914, and L. F. Merrill was appointed. During the seven months, 175 people have called at the office, and 450 farm visits have been made. The letters sent out number 786, and 2,250 people have been addressed at 26 meetings. Newspaper articles number 68. Twenty-eight farm demonstration projects are under way, dealing with orchards, cover crops, legumes, varieties of corn, commercial fertilizers, etc. Quite complete information regarding the various brands of lime and fertilizer are kept on file in the office. Assistance was rendered in establishing a farmers' market in Jersey City. A peach-tree growing contest has been entered into by 918 school children.

The Atlantic county board of freeholders made appropriation for the support of the work to begin November 1, 1914, and Ellwood Douglass was appointed. Burlington county, through its board of freeholders, made an appropriation in March, 1914, to become effective October 1st, but a capable man for this position was not found in time to organize the work promptly on time.

It should be made a matter of record that much demand for the appointment of demonstrators exists in many other counties of the State, and hundreds of petitioners have placed themselves on record favoring action. Some of these counties will secure appropriations without much delay and appointments will be made just as rapidly as thoroughly efficient men can be found.

Designation.

There is oftentimes much in a name. The National Association of Agricultural Colleges and Experiment Stations has accepted the suggestion that the men appointed within the counties should be known as "extension representatives." The thought is that the public should not look upon these men either as "experts" or "agents," but rather as trained men who are present to serve all of the interests of rural life within the county in any possible way. They are representative of the State College and Experiment Station and the National Department of Agriculture in so far as they can connect up the farmers with needed truth when problems are presented. They are in a position to bring specialists to the county when urgent need arises.

Assistant State Leader.

A. L. Clark, who was formerly poultry specialist in the Department of Agricultural Extension, was appointed assistant State leader of county work September 1, 1914. Mr. Clark gives the most of his time to county demonstration work, visiting the various farm demonstrators and helping to inaugurate the work in newly organized counties. He has been granted a leave of absence for three months to take effect November 15th in order that he may direct the farmers' institutes for the State Board of Agriculture.

Co-operation.

In accordance with the provisions of the Smith-Lever act the expenditure of the appropriation made under this law is placed in charge of the College, the only requirement being that the projects have the approval

of the National Department of Agriculture. Appropriation having been made by Congress to the Bureau of Plant Industry for county work, and the bureau being willing to have some of this money expended in New Jersey counties, co-operation was desirable. The director of the extension division became State leader of county work with the approval of the National Department of Agriculture, and the control of work supported by the special funds of the Bureau of Plant Industry was thus placed in his hands. Plans for such expenditures were agreed upon, direction to be left with him, as the plans of work are identical with those laid down in the projects of the division of extension. This plan offers no embarrassment in any way and permits a contribution to a number of organized counties within the State. It is the hope of the National Department that this appropriation may become sufficiently large to permit the contribution of $600 to every county in New Jersey for the support of demonstration work and partial support of the assistant State leader. Temporarily the greater part of the salary of the assistant State leader is paid from bureau funds, but the total amount assigned to New Jersey is not sufficient to permit the suggested amount to be contributed to every county that may organize within the present year. The distribution of this fund has been left with the State leader and the money is being assigned to the counties as rapidly as they are organized for work.

Extension Specialists.

Six projects in the extension division are concerned with demonstration work, respectively, in agronomy, fruit-growing, market gardening, poultry husbandry, home economics and marketing. The law providing for farm demonstration in New Jersey requires the State superintendent to carry on demonstration work on farms throughout the State. The nature and extent of the work accomplished are partly shown in the reports of specialists which are made a part of this report. The aim has been to make our demonstration work practical. Farmers want this assistance in a far greater degree than it can be given. Requests for service far outrun the present ability of the staff. It might be thought that the appointment of county superintendents of farm demonstration would reduce the amount of work made necessary by the State superintendent and his specialists, but experience has shown that the reverse is the case. The activities of the successful county demonstrator inspire confidence in agricultural science, and requests for demonstrations and counsel multiply rapidly. The county demonstrator very rightfully calls for the service of these specialists, and this demand will grow rapidly. At the same time the rights of farmers in unorganized counties cannot be ignored. The law calls for State-wide demonstration, and these specialists must go into these unorganized counties to carry on demonstration work. Unless the number of men attached to the staff can be increased very materially within the coming year it will be impossible to make county demonstration work fully effective and at the same time do the required work in counties that do not have organized local service.

Home Economics.

The Smith-Lever act provided for demonstration work in home economics, and Miss M. Anna Hauser, a graduate of the Pennsylvania State College, was appointed specialist in that line of work September 1, 1914. The very brief time in which she has been at work has served to show that there is wide demand for demonstration in the field of home economics. County superintendents of schools and county farm demonstrators have joined in requests for canning demonstrations for school children and their mothers, and such demonstrations lead later to direct service to the housewives alone. Women's clubs and other associations are making requests for assistance that furnish a wide scope of usefulness for this specialist. During the two months 28 canning demonstrations have been given and 1500 people have been addressed. It is proposed that the broad field of home economics will be covered by means of demonstrations, home visits and the distribution of printed material.

Market Methods.

Many producers within the State are more concerned today with the possibility of securing fair prices for their products than they are with the problems of production, which are fairly well solved in their cases. A serious effort is being made by the division of extension to learn the best methods of distributing the products of the State, and to bring that knowledge to the attention of those who have not been using them. This is a long-time proposition, but one that must be attacked at once and with energy. Prof. M. A. Blake, head of the Horticultural Department, has shown that a proper method of packing peaches and skill in diverting the product to the best market for the day, add most materially to the net returns that may be secured. His success along this one line may be duplicated in many ways.

C. M. Arthur, who was appointed as specialist in market methods September 1st, devotes a portion of his time to a news-letter which is issued by the extension division to all papers circulating within the State. The aim is to carry to the public as quickly as possible the results of station research and general agricultural news.

John H. Voorhees, specialist in agronomy, gives part of his time to the extension division. A. J. Farley resigned as specialist in fruit-growing to take effect September 1, 1914, having accepted a position as instructor in horticulture in the College, and Warren W. Oley, field assistant in the Department of Horticulture, was appointed to fill the position. W. C. Pelton resigned as specialist in market gardening October 1, 1914, and the position has not yet been filled. A. L. Clark resigned as specialist in poultry husbandry September 1, 1914, to accept the position of assistant State leader in county demonstration and Victor G. Aubry, of Orono, Maine, was appointed to this position November 1, 1914.

Lectures.

Demonstration is the central thought in the Smith-Lever act making appropriation for extension work, and also in the State law. There is recognition of the fact that we learn most readily through ocular demonstration and that such demonstration most quickly brings conviction. However, lectures are a necessary attendant upon demonstration, and the method of giving instruction through lectures is a necessary adjunct to demonstration service. The division of extension cannot meet all of the demands for service of this sort preferred by associations of farmers and others, but 24,000 people were addressed by the various members of the staff during the year. The teachings of demonstration and of research and of the practice of the best farmers of the country were taken to those who could not visit demonstration fields or who wanted interpretation of these results.

Rural-life Interests.

One project carried in the extension division which receives far less attention than it deserves is related to rural-life interests. There are many associations within the State supported by people interested in the public schools, the grange, the country church, the county Y. M. C. A. endeavor, civic clubs, etc., that should have whatever assistance they may request from the Agricultural College and Experiment Station, that such an institution is able to give. The ultimate aim of agricultural education and research is the betterment of life for everyone concerned. The State is interested that country life conditions be as attractive as possible financially and socially. The division has responded to many calls from the public for assistance upon the program when men and women have met in the interest of community betterment, and it has been able to render some direct assistance along agricultural lines to institutions serving those who are more or less within the class of unfortunates.

Correspondence.

Direct service through correspondence offers a wide field of usefulness. Many thousands of people within the State are accustomed to write direct to their state institution when problems arise. Much correspondence continues directly with the research departments because the men within the departments are known and trusted by the public. I believe that such direct relations should continue regardless of all that may be said respecting interruptions to research. The public is served and that is the object of educational and research work. It is true, however, that some shift of this burden has been made to the extension division and about 8,000 letters have been written by members of the division within the year.

Publications.

A series of circulars of the Extension Department has been published by the Department of Agricultural Extension within the Station. The

purpose of the circulars so far printed has been to limit the labor of correspondence, placing into the hands of inquirers a concise statement of our best information on any given subject. The very small sum available for printing during the past year has limited the circulars to the following list:

30. *Apple-growing in New Jersey.* 31. *The Establishment of an Apple-*
Orchard. 32. **Diversified Poultry Farming.** 33. **Potato Diseases in New Jersey.** 34. **Crown Gall and Hairy Root.** 35. **Some Diseases of Nursery Stock.** 36. **Grain Smuts; Their Causes and Treatments.** 37. **The Typhoid Fly and Its Associates.** 38. **Advanced Registry Tests in New Jersey.** 39. **Poultry Rations and Methods of Feeding.**

A news-letter to the papers was begun in March, 1913, and nine numbers were published prior to September 18, 1914, when a regular weekly issue began.

Farmers' Week.

The State Board of Agriculture co-operates with the Experiment Station in holding a Farmers' Week at New Brunswick each year. The meeting was held last winter December 26th-31st, and the attendance was estimated at 1500. Nearly every session was held in lecture rooms on the College campus near the railway station to accommodate visitors, and some of the most noted agricultural scientists of the United States assisted in the instructional work. This annual round-up is appreciated by the progressive farmers of the State.

Financial Support.

The definition of extension, with which this report was begun, emphasizes the fact that it is for the benefit of those who are not resident at the College and Station. No money appropriated for extension work can be used for class-room work or research at the State institution. The funds are placed with the division of extension whose business it is to look after outside interests.

The money made available by the Smith-Lever law and the small appropriation made by the State for demonstration work is wholly inadequate as measured by the demands for service. The number of specialists carrying on demonstration work and assisting county demonstrators needs to be increased without delay, and there should be ability on the part of the extension division to make some appropriation directly to county work in each organized county. The amount of money available during the past year was so limited that the Experiment Station contributed over $10,000 to the extension division that was badly needed in research work. This money came from sources that made its use for extension work lawful, but the interests of the State demand that it be kept within the station to which it belongs. Notwithstanding that fact, the Station has contributed $5,000 toward the budget of the extension division the coming year to supplement the money available from the nation and State, in order that the limited amount of work now being

done may be continued. If the appropriation were as liberal as the farmers of the State wish it to be, there would be sufficient funds to permit the State to contribute $1000 annually to every county toward the support of the county farm demonstrator, as he is essentially an agricultural representative of the College, and to increase the staff of specialists carrying on demonstration work throughout the state so that the requests for service might be fully met.

In conclusion it should be wholly proper that I express my deep appreciation of the interest that Dean J. G. Lipman has shown in extension work. The appropriations made by the State and nation could not have been fully effective if they had not been supplemented by funds earned by the Station.

Report of the Extension Specialist in Poultry Husbandry.

ALEXIS L. CLARK.

It may be said that our work has been aimed at two particular points in poultry husbandry; namely, systematized production and efficient marketing. Efforts to secure results in these two directions have been exerted in the following ways: First, by general correspondence; second, by addresses at meetings; third, by fostering educational organizations; fourth, by circulars sent to the members of these associations and other individuals; and, fifth, by personal visitations to poultry plants all over the state.

Introducing Business Methods and Eliminating the Personal Factor in Poultry Farm Management.

We need not go into the reasons why this work seems to be justified as such points have been covered by the various circulars published by the Station in recent years. We have believed that New Jersey is especially adapted to poultry production. Its proximity to the largest and best markets in the world, its transportation facilities, its climate and soil, all lead one to this conclusion. Many years of experience on the part of thousands of poultry raisers convince the student that as a business it has been unreliable and the actual cost of egg production is much higher than a casual observer realizes. We have seen that theoretically eggs could be produced an unknown factor; the overhead charges, average loss by mortality and sickness and unexpected happenings have added to the downfall of many good poultrymen and to the general unsatisfactory condition of the poultry industry. We therefore determined to study poultry raising from the standpoint of pure commercialism, endeavoring to formulate a rather definite system of management that would be equally effective on the large, exclusive poultry farm or on the general farm where the poultry flock is a more or less important adjunct. The various essentials in this year-*round flock management have been discussed* quite thoroughly in recent publications which can be secured from the Station. We will, therefore, take them up here very briefly and consider them chiefly as parts of the entire system.

Management of the breeders. This is a point usually entirely overlooked, but one upon which rests to a very large degree the final outcome of every poultry venture. The breeders must be rested up and should be at the very height of their vigor at the beginning of the hatching season. This is not the case where they are allowed to lay heavily during the winter months or where the birds of either sex are not fully mature.

Early hatching. There are several reasons why chickens should be hatched relatively early. The breeders are in the best physical condition and consequently transmit to their offspring abundant vigor. The season seems to be adapted to growth of chickens, tender green shoots abound, and the moderate weather is conducive to growth. The cockerels may be disposed of for excellent prices as broilers. The pullets may be developed normally and at a low cost on range, yet be ready to begin laying before cold weather starts in.

Artificial incubation and brooding. Where more than a hundred chicks are to be raised the use of incubators and brooders is too well recognized to need discussion. A few points to observe in their management may be suggested. Most incubators will give improved results if the eggs are supplied with moisture. This is well done by the use of sand trays under the egg trays. The eggs may be sprinkled every day with warm water. The chicks should be removed to the brooder just as soon as they are able to stand upon their feet. The brooder must not be crowded; it must be kept at an even temperature and it must have good ventilation. The large coal stove colony brooders are proving their merit but the manufacturers claim too large capacities for them. Where several thousand chickens are to be brooded and especially if the equipment can be used several months in the year it is probable that the long, piped, hot water brooder house is the best.

Dry feed for young chicks and plenty of sour milk. Wheat bran and rolled oats can be given in open dishes with frequent feedings of fine cracked wheat and corn. A well balanced dry mash should be provided at an early age. Sour milk has proved to be of the very greatest benefit to young chicks. It may be fed in the clabbered form and kept continually before them.

Large range with growing green foods for developing young stock. Plenty of room for exercise and plenty of succulent green food are essential in getting good growth at a low cost. A succession of crops may be sown for pasturing. Oats in the spring followed by soy beans, rape and rye in the fall are suggested. Dry mash and mixed grains can be placed about the range in large protected hoppers.

Large colony houses, well ventilated. Much of the trouble from summer colds and poor condition in young chicks during hot weather is due to lack of ventilation in the houses at night. One to two hundred growing chicks make satisfactory flocks. Houses for such purposes are described in one of the "Hints to Poultrymen."

A laying house embodying proper essentials. No other factor excepting the food has so much influence on the production as the laying house. The poultry department has carried on quite extensive investigations in this line and has for the past two years been recommending a certain style of house known as the New Jersey Multiple Unit Laying House. A blue print with working instructions of this house can be secured from the poultry department.

Dry mash and scratching feed. This is the method of feeding that is superseding all other methods. Large home-made dry mash hoppers holding a supply for a week or two form one of the important features of a modern poultry plant. A mixture of cracked and whole grains fed in deep, loose litter night and morning, with some green food at noon, completes the ration. A good mixture with twenty per cent. meat scrap in the mash is recommended. Sour milk or buttermilk is an excellent addition to the ration.

Fall selection of the breeders and old layers. It is a recognized fact now that hens may be profitable layers up to the third year. The condi-

tion of the health and vigor of the individuals is of more importance than the age of the flock. After the moulting is about over, the flock should be handled individually and only those which show indication of vigor and stamina allowed to remain on the plant over winter. The very best should be placed aside for breeders.

The Marketing of Eggs. New Jersey produced eggs are sold in many different ways. There are two points which must be overcome as far as possible to secure an efficient marketing method. In the first place the large majority of poultry keepers are not in a position to retail their eggs or to make extended preparations for placing their eggs where they will return the highest retail prices. On the other hand wholesale selling has meant that eggs must be shipped to one of the large markets, and the prices returned depend entirely upon the will of the buyer. Ordinarily retail selling entails much labor but returns maximum prices. Wholesale selling entails a minimum of labor and returns a low price. Further, retail distribution is limited for our fancy products in the great markets nearby. During the past two years' study of this problem, we found that many were dissatisfied with their poor selling methods. Some were not pleased with really good opportunities. Some were entirely satisfied with the very worst ways of disposing of their eggs and some were satisfied with their own really good methods. We are urging all poultry raisers to investigate their selling methods and convince themselves whether or not they are getting all they should or could out of their hard earned products.

The New Jersey Co-operative Egg Marketing Plan.

At one of the first meetings of the Federation of Poultry Associations this question was discussed and the extension specialist was appointed chairman of a committee to organize a selling plan for the Federation members. This matter is fully discussed under the report of the Poultry Husbandman.

In this co-operative plan the producers send in their eggs in convenient packages and at convenient times. The standard thirty-dozen case is recommended. Authorized agents are selected by the Federation in suitable markets and all eggs are shipped direct to these agents. Each shipper is given a number which shows the agent that the shipper is a member. At the agent's store all eggs are carefully candled and graded and the shipper is given credit for the number and quality of eggs received. The eggs are packed in attractive cartons which advertise the fact that the contents are "Jersey Queen Eggs," produced, graded, packed and sold by the New Jersey Federation of Poultry Associations. A slip inside the carton gives a brief description for the benefit of the consumer of the objects of the Federation and the quality of the eggs. The eggs remain the property of the shipper until they are sold by the agent. The day after the eggs are sold returns are made by the agent to the shipper. The returns are based on the average selling price for the day. A commission of 12 per cent. is deducted from the returns to pay for the agent's work and cost of carton, etc. There are many details of the plan which are discussed at some length in a circular published by the Poultry Department.

Some of the strong points of this plan follow: Minimum amount of work and worry to the producer; insurance of just business dealings in the disposal of products; a greater price than ordinarily received in wholesale selling; an altogether superior and more efficient marketing method; the building up of a reputation for high quality Jersey eggs. The only requirement for shipping under this plan is membership in any one of the thirty-five or more local poultry associations in the State. These associations are described in another paragraph.

We bave studied the markets and market conditions of dressed and live poultry, but so far have done very little in formulating any definite methods of improvement so far as these products are concerned.

Methods of Work.

It was stated in the beginning of this report that results in extension work in poultry husbandry had been secured the past year in five ways. The first mentioned was by correspondence. Of the 5,000 personal letters sent out by the poultry department, the extension specialist sent from 1,000 to 1,500.

The second way mentioned was by lectures and talks at meetings of various kinds. The local poultry associations hold monthly meetings and lectures have been given at almost all of them, and at some more than one. Invitations have been accepted from granges and county boards of agriculture. A number have been given at farmers' institute meetings. About seventy-five talks have been given during the year. The average attendance has been sixty-five, making a total number of nearly 5,000 persons who have heard these lectures. Many of the evening lectures have been accompanied by stereopticon illustrations. The poultry department has 300 slides so that illustrations can be selected for various subjects. , At the institute meetings the State Board of Agriculture furnishes an expert, with lantern. At some of the other meetings local persons have offered to do this. There are no expenses attached to any of these lectures for the organizations giving them or to the people who attend. A few of the rural churches are taking up this matter and it is a point which we urge them to consider more.

The third mentioned method of extension service was by fostering educational organizations, and the fourth by circulating printed matter. There are now over 4,000 poultry raisers enrolled in the membership of these thirty-five associations. For three years small four-page leaflets entitled "Monthly Hints to Poultrymen" have been published by the poultry department each month for their benefit. As many as each association desires are sent to the secretary, who distributes them. These circulars are also used to answer queries on certain subjects from correspondents. The Middlesex County Poultry Association has carried on a chick-raising contest for the school children of the county. The county superintendent asked for something of the kind and the extension specialist suggested this. The poultry department and the local association took the matter up. Entrance blanks were furnished all schools through the co-operation of the supervising principals, and 119 boys and girls entered the contest.

Each child agreed to take twenty-five eggs of some pure variety and set them under two hens, to keep accurate record of eggs and chicks, food consumed, etc., on blanks furnished by the association. About two months after the time limit for setting the eggs had expired each contestant was visited in company with the supervising principal. At the annual exhibition of the association a special class is to be arranged for the contestants. Each one must exhibit one male and one female from the flock raised from the twenty-five eggs. Nearly $100 is offered in prizes to the contestants.

The fifth way mentioned was by visits to plants about the state. These visits take much time and whenever possible several requests in one locality are answered by one trip. Qnite often prospective raisers desire advice regarding the laying out of a new plant. Sometimes general information is desired along several lines. About 100 different poultry plants have been visited during the past year.

Significant Facts.

Most of the successful poultry raisers in New Jersey are in touch with the work of the Experiment Station. Many of them are using the methods recommended by the poultry department. Fewer beginners are starting in headlong with no experience and little judgment. There ought to be still fewer of this class, as they have in the past done much toward giving the industry a poor reputation.

The personal factor is still a very important one. However, we do know a few substantial practices which will do much toward putting the business on a practical footing. A poultry plant is not established until it has been in operation three or four years. We urge poultry raisers everywhere not to experiment with new ideas. A number of men in New Jersey and in many other states have been experimenting for many years. The results secured all agree to a great extent. Surely these results and teachings should receive considerable attention from all, and personal ideas and notions be discarded until the plant has become thoroughly established.

Extension Work in Agronomy.

JOHN H. VOORHEES.

Extension work in Agronomy has been conducted along lines similar to those pursued last year; first, experimental demonstration; second, lecturing; and third, the inspection of farms for counsel regarding better methods for the utilization of fields and the production of general farm crops.

Twelve of the sixteen co-operative demonstrations started last year and planned to show the value of lime and fertilizer used for top-dressing hay were continued and eight new experiments started. These experiments were located in Sussex, Warren, Morris, Hunterdon, Somerset and Middlesex counties upon farms where the common rotation corn, oats, wheat, clover and hay two years, prevails. Results were secured from eight experiments in 1913 and from fourteen in 1914. These results show an average increase in yield caused by the use of 100 lbs. of nitrate of soda, 150 lbs. acid phosphate and 50 lbs. muriate of potash to be 56 and 68 per cent. in 1913 and in 1914, respectively. The application of one ton of ground limestone caused an increase of 11 and 17 per cent., respectively, and an application of both fertilizer and lime caused an increase of 79 per cent. each year. So far results have not shown a profit from the use of ground limestone for top-dressing. Considering the results individually it may be clearly noted that the time of application and the thickness of the sod or in other words, the number of plants of grass per acre, determine to a large extent the profit to be derived from this method.

It has been difficult to induce farmers to grow alfalfa on account of the care required in seeding and the cost of getting a good stand. In an endeavor to find a more readily acceptable method of seeding, a small quantity of seed was forwarded to two farmers in Middlesex county and one in Hunterdon. One drill width was sown by each farmer in his grain instead of clover. Inspection this fall showed only few plants. Results show that this method will prove valuable as a means of securing inoculation, but it is very doubtful whether, even under the best conditions, it will prove satisfactory as a method of seeding alfalfa.

Work with the potato crop has been greatly reduced during the present year. In two cases where sulphur was applied a year ago, timothy and clover failed to grow. One-third of each of these plots was top-dressed with burned lime, one-third with ground limestone, and one-third was held as a check. This was done crosswise the plots. Lengthwise of the plots one-half was seeded in early spring with a mixture of timothy, red clover, red top and alsike. This procedure was planned in order to determine whether the failure of the timothy and clover to grow was caused by increased soil acidity, or to some bacterial action. Unfortunately

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weather conditions were such that the spring seedings had little opportunity to get started so that results are negative in character.

Mr. E. E. Logan, of Mt. Holly, used varying quantities of ground limestone and burned lime on one-quarter acre plots of potatoes. The field had produced potatoes for a number of years and had not been limed for a considerable length of time. The lime was applied on the surface after the potatoes were two or three inches above the ground. It was impossible to give this experiment personal attention and it is doubtful whether the results are dependable, because this was the only experiment of its kind conducted. Mr. Logan's report shows a small increase in yield where lime was used, being about the same regardless of the quantity applied, and apparently there was no material increase in scab or other potato diseases.

The Aroostook county method of fertilization was again tried this year by two excellent farmers, one in Mercer county and one in Salem county. The results were again negative; in fact, the yields were smaller where the extra application was made than on adjoining check plots.

One experiment concerning the fertilization of sweet potatoes, while not conclusive, furnishes a basis for future work. The plan and results follow:

No. of Plot.	Treatment. Rate per Acre.	Yield per Acre in Basket Firsts.	Seconds.
1.	700 lbs. 2-9-10 Fertz.	187	114
	300 lbs. Tankage (9-30)		
	500 lbs. Acid Phosphate		
2.	200 lbs. Muriate of Potash	214	104
	50 lbs. Nitrate of Soda		
	500 lbs. Acid Phosphate		
	200 lbs. Muriate of Potash		
3.	Top-dressing 100 lbs. Nitrate of Soda	208	100
	700 lbs. 2-9-10 Fertz.		
4.	300 lbs. Sulphur	201	105
	700 lbs. 2-9-10 Fertz.		
5.	500 lbs. Sulphur	184	84

Nineteen variety tests with corn have been conducted by farmers in eleven counties. The following varieties of corn secured from without the state were used in these tests: Silver King, Silver Mine, Boone County White, Golden Glow, Pride of the North, Griffith's Early Dent, Darke County Mammouth, Leaming and Reid Yellow Dent. In most cases other varieties or strains secured from farmers within the immediate vicinity of the test were used with the above named varieties. These tests have been somewhat unsatisfactory from an experimental point of view, because soil variations are great and the tests give no fair means of comparison, but an intimacy with each test has given opportunity to compile notes regarding the growing period of each of the different varieties and their adaptability to the climatic conditions of New Jersey.

Neighborhood variety tests or corn demonstrations were conducted at Woodstown, Ashland, Wrightstown and Sergeantsville. At each demonstration a meeting was held in the field at husking time. Variations in yields between high and low amounted to fifteen bushels of shelled corn per acre in three places, and twenty-five bushels at one. The total attendance at the four meetings was 166.

Soy bean work was delegated almost entirely to the individual co-operator. Seed of from three to five varieties, Mammouth Yellow, Medium Green, Swan, Ito San and Wilson, were furnished to each of forty-seven farmers scattered over the state. Printed index cards were also furnished to the co-operators upon which to compile data. The object of this work is to learn more about the time required to mature each of the above named varieties in different parts of the state. The printed cards have not as yet been returned.

The lecture season has been prolific in its opportunities and demands. I have attended forty-one meetings and delivered fifty-two addresses to a total attendance of 2,118 people. In connection with my work for counsel and advice, and for other reasons, I have visited 188 farms during the year. About forty-five farmers were visited during the summer in regard to the formation of a cow testing association which was organized at Woodstown, N. J. I have also inspected eighteen different cranberry bogs owned by fourteen men. These inspections have been purely for counsel and advice regarding questions pertaining to the care and management of cranberry bogs. Until the present no accurate account of the number of letters written has been recorded. A reasonable estimate would place the figure between 850 and 1,000.

Valuable assistance has been received throughout the year from the four county demonstrators now located in the state. To them a part of the credit for the accomplishments of the year is due.

Report of Horticultural Extension Work.

ARTHUR J. FARLEY.

The extension work in horticulture this year has practically been a continuation of the work started last year. The greater part of the time has been spent in practical demonstration work in pruning, spraying and marketing problems; inspection trips to orchards; lectures and general correspondence.

The appointment of Mr. R. Harmer Smith, a Short Course graduate, as an assistant to the extension specialist in Horticulture made it possible for the department to expand and do a large amount of practical demonstration work in pruning and spraying. Two demonstration apple orchards were established, one at Pennington through the co-operation of the owner, Mr. J. C. Erickson, and the Mercer County Farm Demonstrator, Mr. John H. Hankinson; the other at Shiloh on one of the farms operated by Minch Bros., of Bridgeton. These orchards were typical examples of the old neglected orchards found all over the state, many of which might be made profitable by the introduction of modern methods. Both orchards were pruned, sprayed, cultivated, and fertilized under the supervision of the Experiment Station and with the direct assistance of Mr. Smith. The fertilizer and spray materials for the Pennington orchard were furnished by the State, while all similar materials at the Shiloh orchard were furnished by Minch Bros. Practical demonstrations in pruning and spraying were given at both orchards during the season. These demonstrations were very well attended, particularly those held at the Shiloh orchard. Mr. Smith, while in charge of the pruning and spraying, had time to visit neighboring orchards and give specific advice on pruning, spraying and other orchard problems. This feature of the work created much interest in the Shiloh district and seems worthy of further development.

A demonstration peach orchard has been established at New Germantown in co-operation with Mr. Isaac Hildebrandt, Jr. This orchard is in the center of a block of trees set out by Mr. Hildebrandt in the spring of 1914. The demonstration block of trees will be managed according to Experiment Station methods in comparison with the remainder of the orchard which will be handled according to the methods generally practiced in that locality. This orchard will not be used for experimental purposes, but will be used to demonstrate the value of the methods of orchard management recommended by the Experiment Station. It is desired that this orchard, and also the orchard established last year at Lambertville, shall become educational centers for their locality. Demon-

strations will be held from time to time in connection with each operation carried on in the demonstration orchard. A mailing list for each locality will be kept on file at the Experiment Station. This list should include the names of all those within reach of the orchard who are interested in orcharding. Before demonstrations are given or visits made by the extension specialist, cards will be sent to these people inviting them to attend the demonstration or come to the orchard for consultations on horticultural subjects. Such orchards should lead to the formation of horticultural societies to encourage co-operation and more uniform methods of orchard management in the various sections of the State. Several sites have been located for the establishment of similar orchards in other parts of the State.

A portion of the apple orchard of Mr. John Willey, at Hazlet, was used to demonstrate the value of spraying for curculio, scab, and codling moth. This demonstration was conducted in co-operation with Mr. Duryee, Farm Demonstrator of Monmouth County. The extension horticulturist also co-operated with the Department of Plant Pathology in the location of, and conducted spraying experiments in the apple orchard of Mr. John H. Barclay at Cranbury, and the Kieffer pear orchard of Mr. Bolles at Vineland.

Twenty demonstrations in pruning, spraying and peach packing were held in various parts of the State, at which fully 600 people received practical instruction. Pruning and spraying demonstrations were not only held at the demonstration orchards but also at various other farms where the owner was willing to co-operate and was interested in the production of first class fruit.

A large amount of time was given over to inspecting orchards, locating sites for orchards and giving specific advice on all questions pertaining to orchard management. The requests for this service were so numerous during the past year that at least one-half of them had to be refused. Over 150 farms were visited in answer to requests for such inspection.

Twenty-five agricultural meetings were attended at which over 1,925 people were addressed on horticultural topics. The extension specialist in horticulture was present at and assisted in the reorganization of the Vineland Peach Growers' Association and the organization of the Monmouth County Peach Growers' Association. The Horticultural and Agricultural Departments of the Inter-State Fair were again managed by the extension specialist in horticulture and he also acted as fruit judge at the Monmouth County Fair.

Approximately 1,500 letters were written, a large portion of which were answers to inquiries pertaining to fruit growing in the State. An important feature of the extension work in horticulture was the work done in connection with the packing and marketing of peaches. This included, in addition to several packing demonstrations, a trip to the Boston market to note the condition upon arrival of several carloads of peaches shipped from Vineland, N. J.

On September 1st, Mr. W. W. Oley was transferred from the Horticultural Department to the Extension Department, and has had charge of

the extension work in horticulture since that date. Mr. Oley's work has been along the same lines as already mentioned, consisting mainly of inspection trips, correspondence and demonstrations in pruning and the use of dynamite in the orchard. Mr. Oley has inspected 43 orchards and given advice as to their future treatment and advised concerning new plantings. He has written about seventy letters in answer to inquiries.

Recommendations.

I would very strongly recommend that the demonstration orchard be made a prominent feature of the Horticultural Extension work. I would also suggest that all requests for visits to farms, coming from those counties having a farm demonstrator, should first be referred to the demonstrator, who should be advised to visit the farm. If the county demonstrator found a problem that required the services of a specialist, he could then call on the proper specialist for assistance. I believe such an arrangement would relieve the various specialists in the extension departments of many useless trips. Furthermore I would strongly recommend the organization of a first class Experiment Station Exhibit for use at fairs, agricultural meetings, etc. I believe this to be of particular importance in connection with the Horticultural work.

Report of the Department of Farm Crops.

IRVING L. OWEN, FARM MANAGER.
WILLIAM C. BOUGHNER, FOREMAN.

The work of the Department of Farm Crops has been carried on along practically the same lines as last year. Satisfactory progress has been made even though yields were materially reduced by drought. This was especially true with the alfalfa, since seventeen acres was cut only twice and much that was cut for the third time was so small as to hardly pay for the labor.

Daily time records were kept and used as the basis for computing the cost of producing the various crops as tabulated in the following pages, while some of the items in these tables may be open to question, it is hoped that the results of several years computations may help to develop a uniform method of calculating the cost of producing certain crops. While the results of three seasons should not be taken as conclusive, the costs of 1912 and 1913 and 1914 have proved to be quite uniform with the variations resting mainly with the yield and market value items, that are open to natural variation. During the year a two-way plow and a low-down manure spreader were purchased, but in general the machinery equipment is in very poor condition. Additional machines are needed in many cases to do efficient work as well as for instruction in the course of Farm Mechanics. Very recently one of the prominent manufacturers of farm machinery has offered a loan for an indefinite period of a gasoline tractor and a grain thresher for use on the farm as well as for instruction. It is hoped that this example may be followed by others and result in a large endowment of farm machinery for instruction purposes at least.

Timothy Hay.

The ten-acre meadow constituting plots R-Z has been in timothy for four seasons and is holding out unusually well. Heavy coatings of manure were applied in the first two winters but none since. To offset this practice, a Fall top-dressing of fertilizer is being applied to increase the growth of aftermath as well as the usual application in the Spring. The first Fall application was made August 28, 1913, and consisted of 350 lbs. acid phosphate, 50 lbs. muriate of potash, and 100 lbs. nitrate of soda. One acre in the center of the field was left with no nitrate to serve as a check. The large quantity of acid phosphate applied was due to our having used a lime spreader for this material. This machine was not adapted to spreading uniformly lesser amounts per acre.

A marked difference in color was noticeable after a short time between the nitrate and check portions, but as yet the yields have produced no conclusive results.

In March, 1914, oyster-shell lime was applied at the rate of two tons per acre. In Table No. 1 one-fifth of the cost of this lime and labor of applying is charged up to this season's crop. A Spring top-dressing of fertilizer was applied over the entire field consisting of 150 lbs. acid phosphate 50 lbs. muriate of potash and 100 lbs. nitrate of soda per acre.

As will be noted in Table No. 1, the yield was very good and the net profit high. Heretofore high charges have been made against this field for the top-dressing of manure which has lowered the net profit very considerably.

Table No. 1—Timothy Hay.

Plots R-Z—10 Acres.

1913.

Aug. 28—Fertilizer top-dressing: 3,500 lbs. acid phosphate, $17.85; 500 lbs. muriate of potash, $9.40; 900 lbs. nitrate of soda, $24.39; labor applying $7.50; $59.14

1914.

March 23—Applying lime 1-5 of $66.00; $13.20

April 11—Fertilizer top-dressing: 1,500 lbs. acid phosphate, $6.75; 500 lbs. muriate of potash, $9.50; 1,000 lbs. nitrate of soda, $23.50; labor applying $6.00; $45.75.

July 1-11—Mowing: 16 man hours @ 20c. per hour, $3.20; 32 horse hours @ 8c. per hour, $2.56; $5.76.

July 2-15—Curing and cocking: 32 man hours @ 20c per hour, $6.40; 40 horse hours @ 8c. per hour, $3.20; $9.60.

July 6-16—Hauling and storing: 181 man hours @ 20c. per hour, $36.20; 172 horse hours @ 8c. per hour, $13.76; $49.96; total cost: labor, lime and fertilizer, $183.41.

SUMMARY.

Value of crop: 34 tons, 1,000 lbs @ $20.00 per ton, $621.00; total cost: labor, lime and fertilizer, $183.41; total profit: ten acres, $437.59; average cost per acre, $18.34; average profit per acre, $43.76; average cost per ton, $5.32; average profit per ton, $14.68; average yield per acre, 3.45 tons.

Mixed Hay.

This meadow of 14½ acres was sown in August of 1913, with an application of lime and fertilizer at time of seeding. Oyster-shell lime was used at the rate of three tons per acre and the fertilizer mixture consisted of 200 lbs. acid phosphate, 50 lbs. muriate of potash and 50 lbs. nitrate of soda per acre. The cost of seeding, including labor, lime and fertilizer was found to be $23.10 per acre, and one-fifth of this amount is charged against the 1914 crop in the computation in Table No. 2, assuming the seeding to endure for five years.

Through oversight no Spring application of fertilizer was made, still the yield of two and one-half tons per acre was quite satisfactory. A Fall application of fertilizer was made and another is to be made next Spring so that next season's results should be higher. The mixture applied September 9th, consisted of 200 lbs. of acid phosphate and 100 lbs. of nitrate of soda per acre. No muriate of potash was used as only a limited quantity was on hand and no more could be obtained. As the aftermath, especially the clover, made a heavy growth, it was clipped and allowed to lie on the ground. A part of the field has been given a coating of manure during the Fall as no other field was available and here the crop was much lighter and appeared to lack nitrogen.

Table No. 2—Mixed Hay

Field 14 1-2 Acres.

*Cost of seeding 1-5 of $23.10 per acre, $66.99.

June 22-26—Mowing: 34 man hours @ 20c. per hour, $6 68; 68 *horse hours @ 8c. per* hour, $5.44; $12.24.

June 25-29—Curing and bunching: 53 man hours @ 20c. per hour; $10 60; 58 horse hours @ 8c. per hour, $4 64; $15.24.

June 26-July 1—Hauling and storing: 155 man hours @ 20c. per hour, $31 00; 125 horse hours @ 8c per hour, $10.00; $41.00, total cost, seeding and labor, $135 47.

SUMMARY.

Value of crop, 35 tons @ $18 00 per ton, $630 00; total cost of seeding and labor $135.47; total profit of 14½ acres, $494.53; average cost per acre, $9.34; average profit per acre, $34.13; average cost per ton, $3.87; average profit per ton, $14.13; average yield per acre, 2.4 tons.

Alfalfa Hay.

The average yield of alfalfa hay for the season was not high, yet on the whole the results are quite satisfactory and show as in 1913 that alfalfa as a paying crop ranks very high.

Considerable rainy weather was experienced during the harvesting of the second cutting delaying the clearing of the fields. This fact coupled with the drought immediately following resulted in very little growth for the third cutting. About fifteen acres were cut for the third time and the remainder untouched, thus the calculation given in Tables No. 3 and 4 are based mainly on two cuttings. After the second cutting a top-dressing of fertilizer was applied consisting of 300 lbs. of acid phosphate and 100 lbs. muriate of potash per acre.

Field H containing five acres is getting rather thin with a considerable admixture of weeds, affording an excellent opportunity to study the question of renovation by cultivation and reseeding. On September 3rd, this field was harrowed three times with the spring-tooth harrow applying twenty pounds of seed before the last harrowing. One-half acre was left untouched to serve as a check. As the dry weather continued for several weeks after this treatment, no conclusions can be drawn as to the effect of this procedure, either on the eradication of the weeds or the reseeding. It is possible that appreciable results may be noticeable during Spring growth.

Table No. 3—Alfalfa Hay.

Seabolt Field—9 Acres.

First cutting: June 5—Mowing: 8 man hours @ 20c. per hour, $1.60; 16 horse hours @ 8c. per hour, $1.28; $2.88.

June 5-6—Curing and bunching: 32 man hours @ 20c. per hour, $6.40; 24 horse hours @ 8c. per hour, $1.92; $8.32.

June 9-10—Hauling and storing: 69 man hours @ 20c. per hour $13.80; 80 horse hours @ 8c. per hour, $6.40; $20.20; total cost labor, $31.40; cost per acre, $3.49; cost per ton, $1.80; *yield per acre, 1.94 tons.*

Second cutting: July 22-23—Mowing: 17 man hours @ 20c. per hour, $3.40; 32 horse hours @ 8c. per hour, $2.56; $5.96.

July 23—Curing and bunching: 34 man hours @ 20c. per hour, $6.80; 20 horse hours @ 8c. per hour, $1.60; $8.40.

July 23-31—Hauling and storing: 46 man hours @ 20c. per hour, $9.20; 44 horse hours @ 8c. per hour, *$3.52; $12.72; total labor cost, $27.08; cost per acre, $3.01;* cost per ton, $2.27; yield per acre, 1.32 tons.

Third cutting: Aug. 25-27—Mowing: 12 man hours @ 20c. per hour, $2.40; 24 horse hours @ 8c. per hour $1.92; $4.32.

Aug. 26-27—Curing and bunching: 19 man hours @ 20c. per hour $3.80; 30 horse hours @ 8c. per hour, $2.40; $6.20.

Sept. 1-2—Hauling and storing: 24 man hours @ 20c. per hour, $4.80; 18 horse hours @ 8c. per hour, $1.44; $6.24; total labor-cost, $16.76; cost per acre, $1.86; cost per ton, $3.94; yield per acre, 0.47 tons.

SUMMARY OF THREE CUTTINGS.

Value of crop: 33.6 tons @ $20.00 per ton, $672.00; cost of seeding @ $5.00 per acre, $45.00; 2,700 lbs. acid phosphate, $12.15; 900 lbs. muriate of potash, $17.10; total labor cost, $75.24; $149.49; total profit—nine acres, $522.51; average cost per acre, $16.61; average profit per acre, $58.06; average cost per ton, $4.45; average profit per ton, $15.55; average yield per acre, 3.73 tons

Table No. 4—Alfalfa Hay.

Fields A, B, C and H—27 Acres.

June 8–18; July 29–Aug 7; Sept 2–5—Mowing and curing: 219 man hours @ 20c. per hour, $43.80; 268 horse hour @ 8c. per hour, $21.44; $64.24.

Hauling and storing. 125 man hours @ 20c. per hour, $25.00, 120 horse hours @ 8c per hour, $9.60; $34.60.

Cost of seeding @ $5.00 per acre, $135.00; fertilizer top-dressing, $77.75; labor applying fertilizer, $19.24; $231.99; total cost: labor, seeding and fertilizer, $330.83.

SUMMARY.

Value of crop: 89.7 tons @ $20.00 per ton, $1,794.00; total cost: labor, seeding and fertilizer, $330.83; total profit: 27 acres, $1,463.17; average cost per acre, $12.25; average profit per acre, $54.19; average cost per ton, $3.69; average profit per ton, $16.31; average yield per acre, 3.32 tons.

Oat and Pea Hay.

There were 16 acres devoted to this crop, the oats and peas being made into hay. The crop was not exceptional, and, owing to rainy weather during previous haying, not cut quite early enough resulting in considerable shattering of the seed. However, the hay was of fair quality and the income about that of previous years.

The seed was put in at the rate of three bushels per acre mixed half and half. Fertilizer was applied at time of seeding, the mixture consisting of 200 lbs. acid phosphate, 25 lbs. muriate of potash and 75 lbs. nitrate of soda per acre.

Twelve and one-half acres of this area was plowed immediately after harvesting the oats and peas and seeded to mixed hay in August. Seed was sown at the rate of 24 lbs. per acre mixed in the proportion of 12 lbs. timothy, 4 lbs. red clover and 2 lbs. alsike clover. Fertilizer was applied at the rate of 250 lbs. per acre consisting of 200 lbs. acid phosphate and 50 lbs. nitrate of soda, no potash being used.

Table No. 5—Oat and Pea Hay—16 Acres.

April 7–25—Fitting ground and seeding: 183 man hours @ 20c. per hour, $36.60; 376 horse hours @ 8c. per hour, $30.08; $66.68; fertilizer, $48.20; seed, $72,00; $120.20.

July 15–23—Harvesting and storing: 187 man hours @ 20c. per hour, $37.40; 186 horse hours @ 8c. per hour, $14.88; $52.28; total cost: labor, seed and fertilizer, $239.16.

SUMMARY.

Value of crop: 24 tons @ $20.00 per ton, $480.00; total cost: labor, seed and fertilizer, $239.16; total profit, 16 acres, $240.84; average cost per acre, $14.95; average profit per acre, $15.05; average cost per ton, $9.96; average profit per ton, $10.04; average yield per acre, 1.5 tons

Rye Straw and Soy Beans.

The growing of rye straw followed by soy beans for seed as a two-crop proposition has worked out very well this season. The rye was very heavy and although dry weather reduced the yield of soy beans the crop was sufficient to produce a fair income in this crop alone.

The rye was sown in the Fall of 1913 with fertilizer applied at the rate of 200 lbs. acid phosphate, 50 lbs. muriate of potash and 50 lbs. nitrate of soda per acre. The rye was cut during bloom and put in the barn for a few weeks and then baled for market. The field was plowed

after the first rain and planted to Ito San soy beans in rows 28 inches apart using one-half bushel per acre. Fertilizer was applied with the grain drill previous to planting the mixture being 225 lbs. acid phosphate and 75 lbs. muriate of potash per acre. The beans were harvested with the self-rake reaper and threshed from the field. The straw was used in the horse barn for litter as a comparison with sharings had shown this straw to be worth eight dollars a ton when used as litter not including the value in the manure.

Table No. 6—Rye Straw and Soy Beans.

Plots 1-6—6 Acres.

RYE STRAW:

Cost of seeding, $46.00.

May 26-27-28—Mowing: 8 man hours @ 20c. per hour, $1.60; 16 horse hours @ 8c. per hour $1.28; $2.88.

May 29—June 5—Curing and bunching: 25 man hours @ 20c. per hour, $5.00; 30 horse hours @ 8c. per hour, $2.40; $7.40.

June 2-8—Hauling and Storing: 90 man hours @ 20c. per hour, $18.00; 63 horse hours @ 8c. per hour, $5.04; $23.04; total cost of seeding and harvesting, $79.32.

SUMMARY—RYE STRAW.

Value of crop: 11.7 tons @ $14.00 per ton, $163.80; total cost of seeding and harvesting $79.32; total profit of 6 acres, $84.48; average cost per acre, $13.22; average profit per acre, $14.08; average yield per ton, 1.95 tons.

SOY BEANS:

June 15-23—Plowing, fitting ground and planting: 89 man hours @ 20c. per hour, $17.80; 180 horse hours @ 8c. per hour, $14.40; $32.20; fertilizer, $16.34; seed, $6.00; $22.34.

June 29-July 24—Cultivating: 43 man hours @ 20c. per hour, $8.60; 41 horse hours @ 8c. per hour, $3.28; $11.88.

Oct. 1-9—Harvesting and thrashing: 128 man hours @ 20c. per hour, $25.60; 68 horse hours @ 8c. per hour, $5.44; $31.04; total cost: labor, seed and fertilizer, $97.46.

SUMMARY—SOY BEANS.

Total value of crop: 66 bushels of seed @ $2.00 per bushel, $132.00; 4.9 tons of straw @ $8.00 per ton, $39.20; $171.20; total cost: labor, seed and fertilizer, $97.46; total profit—6 acres, $73.74; average cost per acre $16.24; average profit per acre, $12.29; average yield seed per acre, 11 bushels.

SUMMARY—BOTH CROPS.

Value of straw and beans, $335.00; total cost—both crops $178.78; total profit—6 acres $158.22; Average cost per acre, $29.46; average profit per acre, $26.37.

Silage Corn.

There were thirty-six acres in corn mostly of the Reid's yellow dent variety. A high quality seed was used, and while a high price was paid for this seed, $4.50 per bushel, its high germination giving a uniform stand, and the quality of the crop obtained justified the initial cost for seed.

Thirty acres of the corn were cut into the silo while six acres were husked and cribbed, the stalks from the latter being cut up for litter.

The cover crop sown in 1913 was so poor a stand as to be of no consideration. Manure was applied to the 24 acre field (G) at the rate of ten tons per acre. As quite a proportion of this manure is shavings from the litter a charge of only fifty cents per ton is made, particularly as large amounts of fertilizer are used and the idea, to bring this field up in fertility as rapidly as possible, somewhat irrespective of the initial cost.

Fertilizer was applied with the grain drill previous to planting, the mixture consisting of 200 lbs. acid phosphate, 25 lbs. muriate of potash and 75 lbs. nitrate of soda per acre. Additional fertilizer was applied

in the row with the planter, consisting of 50 lbs. bone, 25 lbs. muriate of potash, and 25 lbs. nitrate of soda per acre.

The corn was check-rowed 42 by 36 inches, using a three foot wire. A cover crop of wheat, crimson clover and vetch was sown at the last cultivation but owing to the drought germination was very poor any benefit from the cover crop for next year very doubtful.

Field F is tabulated separately as this area was an old pasture growing a crop for the first time in 1913. This field is being improved as rapidly as possible. Last season there was a loss owing to high quantities of lime and fertilizer as well as extra labor. This season while the income is low there is a small net profit.

Table No. 7—Silage Corn.

Field G—24 Acres.

May 1-20—Plowing and fitting ground: 307 man hours @ 20c. per hour, $61.40; 614 horse hours @ 8c. per hour, $49.12; $110.52.

May 21-26—Applying fertilizer and planting: 135 man hours @ 20c. per hour, $27.00 270 horse hours @ 8c. per hour, $21.60; $48.60.

June 3; July 24—Cultivating and hoeing: 272 man hours @ 20c per hour, $54.40; 252 horse hours @ 8c. per hour, $20.16; $74.56; fertilizer, $117.00; seed, $18.00; manure, $120.00; $255.00.

Sept. 15-30—Putting in silo, $225.00; total cost: labor, seed, manure and fertilizer, $713.68.

SUMMARY.

Value of crop: 204 ½ tons @ $5.00 per ton, $1,022.50; total cost—labor, seed, manure and fertilizer, $713.68; total profit—24 acres, $308.82; average cost per acre, $29.74; average profit per acre, $12.87; average cost per ton, $3.49; average profit per ton, $1.51; average yield per acre, 8.5 tons.

Table No. 8—Silage Corn.

Field F—6 Acres.

May 23-June 1—Plowing and fitting ground: 117 man hours @ 20c. per hour, $23.40; 234 horse hours @ 8c. per hour, $18.72; $42.12.

June 6—Applying fertilizer and planting: 23 man hours @ 20c. per hour, $4.60; 42 horse hours @ 8c. per hour, $3.36; $7.96.

June 14-July 24—Cutivating: 35 man hours @ 20c. per hour, $7.00; 68 horse hours 8c per hour, $5.44; $12.44; fertilizer, $29.22; seed $4.50; $33.72.

Sept. 20-30—Putting in silo, $22.50; total cost: labor, seed and fertilizer, $118.74.

SUMMARY.

Value of crop: 30 tons @ $5.00 per ton, $150.00; total cost—labor, seed and fertilizer, $118.74; total profit—6 acres, $31.26; average cost per acre, $19.79; average profit per acre, $5.21; *average cost per ton, $3.96; average profit per ton, $1.04; average yield per acre, 5 tons.*

Table No. 9—Ear Corn.

Field E—6 Acres.

April 20-May 18—Plowing and fitting ground: 53 man hours @ 20c. per hour, $10.60; 106 horse hours @ 8c. per hour, $8.48; $19.08.

May 18-20—Applying fertilizer and planting: 32 man hours @ 20c. per hour, $6.40; 60 horse hours @ 8c. per hour, $4.80; $11.20.

June 2-30—Cultivating and hoeing: 40 man hours @ 20c. per hour, $8.00; 56 horse hours @ 8c. per hour, $4.48; $12.48.

Cutting and shocking, $25.00; husking and cribbing, $40.80; $65.80; fertilizer, $29.22; seed, $4.50; $33.72; total cost: labor, seed and fertilizer, $142.28.

SUMMARY.

Value of crop: 360 bushels of corn @ 80c. per bushel, $288.00; 6 tons stover @ $8.00 per ton, $48.00; $336.00; total cost: labor, seed and fertilizer, $142.88; total profit—6 acres, $193.12 average cost per acre, $23.81; average profit per acre, $32.18; average yield per acre 60 bushels corn; 1 ton stover.

Report of the Soil Chemist and Bacteriologist.

JACOB G. LIPMAN
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POT EXPERIMENTS ON THE AVAILABILITY OF NITROGEN IN MINERAL AND ORGANIC COMPOUNDS.

A large number of pot experiments dealing with the availability of nitrogen in different materials have already been reported by this Station. In the majority of these experiments it has been customary to use one or two grams of nitrate of soda for twenty pounds of soil or sand, and an equivalent amount of nitrogen from other sources. Since the nitrogen of nitrate of soda is more readily available than that of sulphate of ammonia and organic nitrogenous materials it is possible that a moderate application of this would place the other materials, when used in equivalent amounts, at a disadvantage. It seemed worth while therefore to try a large amount of nitrate with correspondingly large amounts of the other materials, and in experiment No. 1, 4 grams of the nitrate were used with equivalent amounts of sulphate of ammonia, tankage and cotton seed meal.

EXPERIMENT No. 1. Earthenware pots holding twenty pounds of sand were used. Each pot received 4 grams acid phosphate, 2 grams potassium sulphate, 5 grams ground limestone, 0.5 gram magnesium sulphate, and 0.25 gram iron sulphate. In addition to this treatment nitrogenous fertilizer materials were applied as indicated in the table. The moisture was maintained at about 10 per cent. Twenty-two barley seeds were planted in each pot and the crop grown to maturity. The *weight of dry matter produced and percentage of nitrogen recovered* are shown in Table I.

Table I—The Recovery of Nitrogen From Different Materials.

Pot No.	SPECIAL TREATMENT.	First Crop—Barley. Nitrogen applied mgs	Dry matter gms.	Per cent. nitrogen.	Average nitrogen mgs.	Per cent. nitrogen recovered.	Residual Crop—Barley. Dry matter gms.	Per cent nitrogen.	Average nitrogen mgs	Per cent. nitrogen recovered.	Per cent. nitrogen recovered, both crops
1		...	0.8	0.767			0.5	0.687			...
2	No Nitrogen. . . .	...	0.7	0.698	5.39		0.5	0.828	3.98		...
3		...	0.6	0.856			0.5	0.872			
4		616	10.5	3.039			3.5	1.933			
5	4 gms. NaNO3 (15.4%).	616	10.5	3.029	314.32	50.15	6.0	1.560	82.31	12.71	62.86
6		616	9.2	3.321			5.9	1.452			
7		616	13.8	2.390			4.5	0.961			
8	2.92 gms. (NH2)4 SO4 (21.07%) .	616	13.7	2.498	331.24	52.90	4.5	0.971	13.70	6.45	59.35
9		616	11.2	2.872			5.0	0.883			
10		616	11.8	1.878			3.6	0.893			
11	5.77 gms Tankage (10.68%). . .	616	10.8	2.115	223.25	35.37	3.9	0.961	32.43	4.62	39.99
12		616	9.8	2.242			3.0	0.922			
13		616	12.5	1.485			2.6	1.383			
14	9.62 gms. C. S. Meal (6.4%). . . .	616	12.5	1.495	186.05	29.33	3.0	1.285	37.48	5.44	34.77
15		616	12.5	1.485			3.0	1.265			

The highest average yield of dry matter is with ammonium sulphate, and the next highest with cotton seed meal. It is of especial interest to note the wide variation in nitrogen content of the dry matter. The average for the check pots is 0.77 per cent. The average for the nitrate pots is 3.13 per cent. which is more than four times the amount for the check pots. The average for the ammonium sulphate pots is 2.587 per cent., for the tankage 2.078 per cent. and for the cotton seed meal 1.488 per cent.

This confirms work already reported and indicates that where available nitrogen is present the plant will take it up even to the point of injury. Thus, in a way, the plant measures the availability of the materials, though the amount applied is an important factor to be considered. The higher yield of dry matter with ammonium sulphate more than offsets the lower percentage of nitrogen and gives a higher percentage recovery. The yield of dry matter with cotton seed meal is higher than with tankage, but the percentage of nitrogen in the dry matter with tankage is enough higher to give a higher recovery than with cotton seed meal.

Residual Crop.

A second crop of barley was grown in these pots without further fertilizer treatment. The results from this second crop are shown in tabular form as a part of Table 1. It will be noted that the yield of dry matter is, in all cases where the nitrogenous fertilizers were used, much less than in the first crop. Likewise the percentage of nitrogen is in most cases less than half what it was in the first crop. The cotton seed meal seems to prove an exception, however, for here the percentage of nitrogen is nearly as high as in the first crop, indicating a fair supply of readily available nitrogen. Apparently the cotton seed meal decomposed slowly and gave up less of its nitrogen to the first crop than did the other materials. The results with the other materials make it quite certain that with distinctly diminishing nitrogen supply there is not only a diminished yield but also a lower percentage of nitrogen in the dry matter.

The recovery of nitrogen from nitrate of soda with this crop is approximately double the recovery from ammonium sulphate, which makes the total recovery from nitrate 62.86, while the total recovery from ammonium sulphate is only 59.35. In the residual crop the recovery from cotton seed meal is 5.44 per cent. as against 4.62 for the tankage.

The results indicate that on account of the ready availability of the nitrogen of nitrate of soda it is not quite fair to compare recoveries from this with recoveries from equivalent amounts of materials not so readily available, if the application is a small or moderate one, and if only one crop is grown. If large applications of ammonium sulphate are made, resulting in an immediate supply of readily available nitrogen from the ammonium sulphate, or if the residual crop is taken into consideration then an equivalent amount of nitrate should have no unfair advantage over the ammonium sulphate.

Experiment No. 2. In this experiment twenty pounds of sand were used as in No. 1, but nitrate of soda was the only mineral nitrogenous material used, the other materials all being organic. The general conditions were the same except that each pot received double the amount of minerals applied in Experiment No. 1, and the crop was buckwheat instead of barley, the latter being grown in the winter and the former in the summer.

In this instance 3 grams of nitrate of soda were used and equivalent amounts of the organic materials as indicated in the table.

Table II.—The Recovery of Nitrogen From Different Materials.

Pot No.	SPECIAL TREATMENT.	Buckwheat—1913. Nitrogen applied mgs.	Dry matter gms.	Per cent. nitrogen.	Aver. nitrogen mgs.	Per cent. nitrogen recovered.	Barley 1914 (residual crop). Dry matter gms.	Per cent. nitrogen.	Average nitrogen mgs.	Per cent. nitrogen recovered.	Per cent. nitrogen recovered, both crops.
1			0.9	1.443			2.1	0.767			
2	No Nitrogen	....	0.8	1.661	13.22	.....	2.0	0.718	15.57	....	....
3			0.7	1.910			2.2	0.738			
4			15.2	2.112			6.2	0.885			
5	3 *gms* Na NO_3	462	15.0	2.006	305.18	63.19	6.2	0.885	55.41	8.62	71.81
6			14.5	2.025			6.6	0.856			
7			8.0	1.693			5.5	0.777			
8	16.985 gms. Alfalfa Meal	462	7.3	1.725	130.69	25.43	5.2	0.738	40.56	5.41	30.84
9			*2.5	*2.287			*7.9	*0.856			
10			10.0	1.754			5.8	0.757			
11	12.126 gms. Green Rye	462	9.3	1.512	158.82	31.52	7.0	0.767	47.81	6.98	38.50
12			9.3	1.725			5.9	0.777			
13			12.6	1.802			4.6	0.787			
14	3.774 gms. *Dried Blood*	462	11.7	1.841	212.69	43.17	5.9	0.777	42.12	5.74	48.91
15			9.8	1.996			5.5	0.806			
16			8.2	2.122			5.9	0.777			
17	7.213 gms. Cotton Seed Meal	462	*4.2	*2.535	177.20	35.49	*9.0	*0.797	42.74	5.88	41.37
18			10.7	1.686			5.1	0.777			

*Omit from Average.

With two exceptions the triplicate weights agree quite well, the nitrate of soda giving the highest average yield and the dried blood second highest. With the exceptions noted the percentages of nitrogen are also fairly concordant.

The nitrate gives a uniform percentage slightly above two per cent., while the average for the dried blood is a little below two per cent.

The recovery with nitrate of soda is 63.19 per cent. and with dried blood it is 43.17 per cent. It is of interest to note that these figures are very close to results obtained in earlier work at this Station,[1] both pot and cylinder experiments, and also to the results obtained in Germany.

The recoveries for the other materials agree quite well with recoveries heretofore obtained with vegetable nitrogenous materials.

Residual Crop.

Following the buckwheat the pots were seeded to barley without the further addition of fertilizers, the aim being to utilize the remaining nitrogen. The results constitute a part of Table II.

Again the recovery with nitrate of soda is highest though all recoveries are low, indicating that the available nitrogen was largely utilized by the first crop. We should naturally expect the residual crop to show higher recoveries with the organic materials than with nitrate of soda, but this is not so in this case. Just why more of the organic nitrogenous material should not become available for the second crop is not clear. Further work along this line is being carried on. It is very probable that had the soil been subjected to the leaching action of rain the recovery from nitrate with the second crop would have been lower.

EXPERIMENT NO. 3. For this experiment pots holding twenty pounds of sand were used. Nitrate of soda was used alone and in combination with vegetable and animal organic matter. Where used alone 4 grams of the nitrate were applied to each pot and the organic materials were used in equivalent amounts. When used in combination one half the nitrogen was taken from nitrate and one half from the organic materials. All pots received the double portion of mineral materials as in Experiment No. 2. Buckwheat was planted for the first crop and barley for the second or residual crop. The crops were grown to maturity but grain and straw were harvested together. The results are reported in Table III.

1 Factors Relating to the Availability of Nitrogenous Plant-Foods. Bulletin No. 251 N. J. Agricultural Experiment Station; pages 44-47.

Table III—The Recovery of Nitrogen From Different Materials.

Pot No.	SPECIAL TREATMENT.	Nitrogen applied mgs.	Buckwheat—1913. Dry matter gms.	Buckwheat—1913. Per cent nitrogen.	Buckwheat—1913. Average nitrogen mgs.	Buckwheat—1913. Per cent. nitrogen recovered.	Barley—1913-14. Dry matter gms.	Barley—1913-14. Per cent nitrogen.	Barley—1913-14. Average nitrogen mgs.	Barley—1913-14. Per cent. nitrogen recovered.	Per cent. nitrogen recovered, both crops.
1	No Nitrogen	......	0.5	1.550	7.65	......	2.2	0.806	17.03	......	......
2			0.5	1.507			2.0	0.816			
3	4.00 grams Na NO_3	616	21.0	2.103	438.25	69.90	5.2	0.816	36.53	3.17	73.07
4			21.1	2.061			3.8	0.806			
5	22.65 grams Alfalfa Meal	616	10.3	1.521	166.26	25.75	5.5	0.915	54.32	6.05	31.80
6			9.5	1.851			5.3	1.100			
7	16.17 grams Green Rye	616	9.6	2.093	201.70	31.50	6.5	0.806	53.04	5.85	37.35
8			9.9	2.045			7.0	0.767			
9	5.03 grams Dried Blood	616	13.7	1.957	216.48	33.90	5.2	0.777	55.20	6.20	40.10
10			7.0	2.355			8.0	0.875			
11	5.77 grams High Grade Tankage	616	11.7	2.074	224.49	35.20	6.3	0.816	55.28	6.21	41.41
12			12.1	1.705			6.2	0.954			
13	8.58 grams Low Grade Tankage	616	9.2	1.957	240.22	37.75	7.8	0.944	52.75	5.80	43.55
14			15.2	1.938			4.1	0.777			
15	2.00 grams Na NO_3	616	13.5	2.054	257.72	40.60	4.7	1.277	72.89	9.07	49.67
16	11.32 grams Alfalfa Meal	616	12.6	1.890			8.0	1.072			
17	2.00 grams Na NO_3	616	17.0	1.986	332.69	52.77	5.0	0.816	41.05	3.90	56.67
18	8.08 grams Green Rye	616	17.9	1.831			5.0	0.826			
19	2.00 grams Na NO_3	616	15.2	2.054	316.02	50.06	7.2	0.826	50.77	5.48	55.54
20	2.52 grams Dried Blood	616	14.8	2.161			5.7	0.738			
21	2.00 grams Na NO_3	616	15.7	2.112	333.29	52.85	5.1	0.973	51.98	5.67	58.52
22	2.88 grams H. G. Tankage	616	16.0	2.093			6.5	0.836			
23	2.00 grams Na NO_3	616	15.5	2.122	331.13	52.51	6.0	0.728	34.59	2.85	55.36
24	4.28 grams L. G. Tankage	616	17.2	1.938			3.6	0.718			
25	4.00 grams Na NO_3	616	11.8	2.141	272.48	42.99	9.9	1.560	128.83	18.15	61.14
26			14.5	2.016			6.6	1.564			

With two or three exceptions the duplicate weights are concordant. The highest yield is with nitrate of soda It is of interest to note that the average weights where organic matter alone was used are without exception lower than the average weights where the same amount of nitrogen is used in the form of nitrate of soda and organic matter combined. With slight exception the percentages of nitrogen run uniformly close to two per cent. However, where no nitrogen was applied it is only a little over one and one-half per cent. The highest recovery 69.90 per cent. is with nitrate of soda and it is again to be noted that the recovery with the combined nitrate and organic matter is invariably higher than the recovery with organic materials alone, the average for the former being 49.76 and for the latter 32.82. This points to increased efficiency through such combination and bears out work previously reported which seemed to show that the presence of nitrates in the soil stimulates the ammonification of organic nitrogenous matter. With nitrogen as nitrate of soda costing no more than nitrogen as organic matter, and sometimes less, depending upon the source of the organic nitrogen, the results of this experiment seem to fully justify the farmer in using nitrate of soda along with his organic matter, if conditions require that he use some commercial organic materials.

Residual Crop.

With the idea of utilizing the nitrogen as fully as possible, barley was seeded as a second or residual crop to be grown during the winter of 1913-14. No further fertilizers were applied. The second part of the table gives the results obtained with this residual crop.

It will be noted that the yields of dry matter are small in all pots. It is to be futher noted, however, that the yields from the pots which received the organic materials alone, and the organic materials combined with nitrate of soda, gave a higher yield than the nitrate alone. This is unquestionably to be attributed to the residual effects of the organic fertilizers, which, on account of gradual decomposition, were not utilized to so great an extent by the first crop. The percentage of nitrogen in the barley is in most cases less than one per cent., which is scarcely half what it is in the buckwheat. This clearly points to a deficiency of available nitrogen for the residual crop, since in other experiments barley has shown percentages of nitrogen varying from two to three per cent. when an abundance of available nitrogen was supplied. Attention may be called to an average slightly above one per cent. where alfalfa meal was used with the nitrate of soda. This points to alfalfa as furnishing more readily available nitrogen than the other organic materials.

The percentage of nitrogen recovered is low in all cases, except with nitrate of soda in pots 25 and 26, and this high residual recovery must be attributed to the fact that the large application of nitrate to the first crop somewhat injured the plants so that they did not develop and utilize the nitrogen to the fullest extent possible. It was noted on one or two

occasions that the plants in these pots showed signs of injury from excessive amounts of nitrogen. The plants in pots 3 and 4, where the same amounts of nitrate was used, do not appear to have been injured.

Excluding the high residual recovery from pots 25 and 26, the highest recovery, 9.07%, is with nitrate and alfalfa meal, and the lowest with nitrate and low-grade tankage. The residual recovery from nitrate in pots 3 and 4 is lower than the recovery from the organic materials, and, with one exception, lower than the recoveries from the combination of nitrate and organic materials. This is explained by the high recovery from these pots with the first crop.

When the sum of the recoveries for the two crops is taken, we find the nitrate standing highest, while the recoveries from the combination of organic matter and nitrate still stand higher than the recoveries from the organic materials alone.

Four points appear to be especially emphasized in this experiment.

1. The residual effects from the use of nitrate of soda are small, if the first crop develops normally, but are considerably increased where an excessive amount of the nitrate depressed the yield of dry matter in the first crop.

2. The residual effects from the use of organic nitrogenous materials are greater than the residual effects from nitrate of soda (with the exception noted in 1), but they are small when considered from the standpoint of the amount of nitrogen that apparently remains in the soil after the removal of the first crop.

3. The unaccounted-for nitrogen in the organic materials must have been dissipated, or it must remain in the soil in an unavailable form.

4. Nitrogen applied in the form of nitrate of soda and organic matter, half the nitrogen from one and half from the other, gives a higher yield of dry matter and a higher recovery of nitrogen than nitrogen which is all in the form of organic matter.

Further investigations are being carried out to determine, if possible, why less than 50% of the nitrogen of the organic matter is recovered.

EXPERIMENT No. 4. This experiment is a continuation of the work on the availability of mineral and organic nitrogenous materials. Two grams of nitrate of soda were used and quantities of the other materials to furnish an equivalent amount of nitrogen. The experiment was carried out in pots holding twenty pounds of pure white sand. To each pot there was added 4 grams acid phosphate, 2 grams potassium sulphate, 5 grams ground limestone, 0.5 gram magnesium sulphate, and 0.25 gram ferric sulphate. The moisture was maintained at about ten per cent. Buckwheat was grown to maturity during the summer of 1913 and grain and straw were harvested together. The special treatment given and data with reference to the yield of dry matter and yield of nitrogen are shown in Table IV.

Table IV—The Recovery of Nitrogen From Different Materials.

Pot No.	SPECIAL TREATMENT.	Nitrogen applied mgs.	Dry Matter gms. Per pot	Dry Matter gms. Average.	Per cent. Nitrogen.	Total Nitrogen mgs. Per pot.	Total Nitrogen mgs. Average.	Increase over Check.	Per cent. Nitrogen recovered.
1			0.9		1.415	12.74			
2	No Nitrogen.		0.9	1.30	1.407	12.66	19.65	. . .	. . . .
3			2.1		1.597	33.54			
4			13.7		1.787	244.82			
5	2 gms Na NO	308	15.1	14.03	1.863	281.31	260.10	240.45	78.07
6			13.3		1.911	254.16			
7			13.5		1.178	159.03			
8	1.460 gms. (NH_4) SO_4.	308	13.5	13.43	1.654	223.29	198.64	178.99	58.11
9			13.3		1.606	213.60			
10			17.5		1.454	254.45			
11	0.918gms. (NH_4) NO_3 .	308	18.5	16.97	1.027	190.00	213.76	194.11	63.02
12			14.9		1.321	196.83			
13			5.6		2.557	143.19			
14	1.970 gms. $CaCN_2$	308	5.9	5.77	1.787	105.43	129.18	109.53	35.56
15			5.8		2.305	138.91			
16			18.7		1.027	192.05			
17	2.660 gms. Ca $(NO_3)_2$	308	16.6	17.93	1.625	269.75	240.70	221.05	71.77
18			18.5		1.407	260.30			
19			14.1		1.321	186.26			
20	2.430 gms. Dried Blood	308	14.0	13.73	1.264	176.96	183.34	163.39	53.15
21			13.1		1.426	186.81			
22	Green Rye,		*21.3		*2.281	*485.85			
23	8.084 gms. (Dried and Ground). .	308	7.2	7.20	1.280	92.16	99.07	79.42	25.79
24			7.2		1.472	105.98			
25			7.2		1.409	101.45			
26	11.323 gms. Alfalfa Meal. . .	308	6.3	6.57	1.261	79.44	90.08	70.43	22.87
27			6.2		1.441	89.34			

*Omit from average.

The yields of dry matter in the triplicate pots are, with two or three exceptions, in fair agreement. The highest average yield was obtained with calcium nitrate, and the next highest with ammonium nitrate. The lowest yield, which is less than one third the yield with calcium nitrate, is with calcium cyanamid. Here there were unmistakable evidences of toxic effects from the fertilizer. On August 1 it was noted that the leaves were small and stalks slender. It is not entirely clear why this material should thus prove toxic, but the low yield of dry matter and unusually high percentage of nitrogen, 2.557 in the case of pot 13, indicate an abnormal condition. Notwithstanding the stunted growth of the plants they took up nitrogen in larger quantities than plants showing normal growth. It is entirely possible that this abnormal storing up of nitrogen accounts for the failure of the plants to make normal development. Generally speaking the percentage of nitrogen in the crops from those pots that received organic nitrogenous materials is lower than it is in plants from pots that received mineral nitrogenous materials. This must be explained on the ground that these organic materials supply

nitrogen in a moderately available form. It may be observed that these percentages are in most cases a little below the percentages in the check pots.

The highest recovery of nitrogen is 78.07 per cent. with nitrate of soda, and the next highest 71.77 with calcium nitrate. The recovery with ammonium nitrate although not so high as the recovery with sodium or calcium nitrate is higher than the recovery with ammonium sulphate. The recovery with calcium cyanamid is only about one half that with calcium nitrate, the low recovery here necessarially following the low yield. The recovery with dried blood is somewhat higher than is usually secured with this material. The recoveries with the ground green rye and alfalfa meal are about the same as are usually obtained with vegetable nitrogenous materials.

The results obtained here conform in the main with the results obtained in previous experiments. It may be pointed out that the toxic effect observed in connection with calcium cyanamid would have been lessened and in all probability entirely obviated had the plants been grown in soil rather than sand, for the reason that soils possess a greater power of absorbing toxic materials and making them harmless than does sand.

Experiment No. 5. In this experiment materials representing green manure crops are used alone, with nitrate of soda, and with nitrate of soda and ground limestone, the object being to determine whether or not the ground limestone aids in the decomposition of the organic matter and the production of available nitrogen. Pots holding nine pounds of loam soil were used. As a general treatment, all pots received 4 grams acid phosphate, 2 grams potassium sulphate, 2 grams ground limestone, 0.5 gram magnesium sulphate and .25 gram ferric sulphate. The moisture was maintained at about 15 per cent. The 2 grams of ground limestone, applied as a part of the general treatment, was intended to establish average conditions for growth in all pots, while to certain of the pots 10 grams additional ground limestone were applied in order that in these pots there might be an excess of this material. The organic materials were chopped up, ground and mixed in the soil. Definite weights of these were applied without taking into consideration the amount of nitrogen thus furnished. Buckwheat was grown in these pots during the summer of 1913, and this was harvested without separating grain and straw.

The special treatment given, together with the yield of dry matter, percentage of nitrogen and the increase of nitrogen over the check, are shown in Table V.

Table V—The influence of Ground Limestone on the Decomposition of Green Manure.

Pot No.	SPECIAL TREATMENT.	Nitrogen applied mgs.	Dry matter grms.	Per cent. nitrogen.	Average nitrogen mgs.	Increase over checks mgs.	Per cent. nitrogen recovered.
1 2	No Nitrogen. .		6 0 5 7	1.105 1 347	71.54	Av. checks 81.22	. .
3 4	2 gms Na NO_3	308	15.0 14 7	1 948 2.054	297.07	215.85	70 08
5 6	30 ms. Green Alfalfa . .		15.4 13 7	1 463 1.521	216 84	135.62	. . . . .
7 8	30 gms. Green Alfalfa + 10 gms. $CaCO_3$		16 7 15 0	1 424 1 560	235.91	154 69	.
9 10	2 gms. $NaNO_3$ + 30 gms Green Alfalfa. .		11.2 14.1	2 277 2.306	290.09	208.87	. . .
11 12	2 gms. $NaNO_3$ + { 30 gms Green Alfalfa. . / 10 gms. $CaCO_3$. .	. . .	16.6 19.1	2 422 2 355	425.93	344.71	. . . .
13 14	2 gms. $NaNO_3$.	308	14.0 12.0	1.996 2.074	264.16	182.94	59 40
15 16	*30 gms. Green Timothy*.	. . .	7 7 10.5	1 326 1 298	*119.20*	*37.98*	. . . . .
17 18	30 gms. Green Timothy + 10 gms $CaCO_3$		10 0 9.9	1.260 1 260	125.37	44 15	. . . .
19 20	2 gms. $NaNO_3$ + 30 gms. Green Timothy. .	. .	13 2 13 5	2.045 1 744	252.69	171.47	. . .
21 22	2 gms. $NaNO_3$ + { 30 gms Green Timothy / 10 gms $CaCO_3$ . . .	. .	13 3 15.5	2.238 2.141	314.76	233.54	. . . . .
23 24	2 gms. $NaNO_3$.	308	15.0 13 0	2 132 1.986	288 99	207.77	67 46
25 26	30 gms. Green Oats and Peas	. .	11.6 7 3	1.376 1.783	144 89	63.67	. . . .
27 28	30 gms. Green Oats and Peas + 10 gms. $CaCO_3$.	. . . .	14.7 13.0	1.269 1.337	180 18	98.96	. . . .
29 30	2 gms. $NaNO_3$ + 30 gms. Green Oats and Peas.	. . . .	14.1 12.2	2.326 2.306	304.65	223.43	. . . .
31 32	2 gms. $NaNO_3$ + { 30 gms. Gr. oats & peas / 10 gms. $CaCO_3$.	. . .	16.2 17.8	2.200 2.219	375.69	294.47	. . . . . .
33 34	No Nitrogen.	. . .	7.8 7.9	1.163 1.153	90.90	Av. checks 81.22	. . . . . .

With two or three exceptions, the duplicate weights agree nicely. In every instance the average yield of dry matter is higher with the ground limestone than without, and this is true whether it is used with the green manure alone, or with the green manure and nitrate of soda. The highest average yield, 17 grams, occurs in pots 31 and 32 where the ground limestone is used with nitrate and green oats and peas, while the lowest yield, 9.1 grams, occurs with green timothy alone.

The percentage of nitrogen varies from a little more than 1 per cent. for the checks to nearly 2½ per cent. where limestone is used in connection with nitrate and green alfalfa. The percentage of nitrogen is invariably higher where nitrate is used in connection with the green crop, both limed and unlimed, or the green crop in connection with limestone.

The highest average amount of nitrogen recovered is 425.93 grams where limestone is used with nitrate and green alfalfa; the smallest amount, excluding the checks, is 119.2 grams with green timothy alone. Where limestone is used with green manures, the increase over the check is invariably greater than where the green manure is used alone. Also, where limestone is used in connection with nitrate and green manure, the increase is invariably greater than where the nitrate and green manure are used without limestone. Thus, the average increase for pots 9 and 10, with 2 grams of nitrate and 30 grams of alfalfa, is 208.87 grams, while with these materials plus 10 grams of limestone, it is 344.71 grams. The increase with 2 grams of nitrate and 30 grams of green timothy is 171.47 grams, and, with the nitrate and green timothy plus 10 grams of limestone, it is 233.54 grams. The increase with 2 grams of nitrate and 30 grams of green oats and peas is 223.43 grams, and, with the nitrate and green oats and peas plus the 10 grams of limestone, it is 294.47 grams. It is, therefore, quite evident that the limestone did aid in the decomposition of the organic matter and in making the nitrogen more available. It is quite clear, likewise, that the nitrogen of leguminous crops becomes more quickly available than the nitrogen of the non-leguminous crops.

Farmers have sometimes complained that the turning under of green crops "sours" or "deadens" the soil. Undoubtedly, such conditions have been observed, and it is quite possible that this deadening of the soil is due to fermentation and slow decomposition of green crops that have been turned under, and that a liberal application of ground limestone, made before the green crops are turned under, would largely obviate this difficulty. The results of this experiment point to such treatment as the solution for this difficulty.

Experiment No. 6. The object of this experiment was very much the same as that of No. 4, that is to determine whether the presence of green vegetable matter in the soil interferes with the germination of seed and the growth and development of plants, and further to determine the effect of ground limestone on the decomposition of such green materials and the formation of available nitrogen.

A mixture consisting of nine pounds of sand and nine pounds of loam soil was used. As a general treatment, all pots received 2 grams nitrate of soda, 4 grams acid phosphate and 2 grams potassium sulphate, all of which were thoroughly mixed with the soil. 10 per cent. of water was allowed for the sand and 15 per cent. for the soil. The green rye was chopped up and placed in a layer about four inches beneath the surface of the mixture to represent a green crop turned under. Where

ground limestone was used, this was sprinkled over the green rye. (It may be noted here that the results would probably have been more satisfactory had the green rye and ground limestone been mixed with the top three or four inches of the soil instead of being placed in a compact layer.)

Barley was grown during the winter of 1913-14, and harvested at maturity. The dry weights were recorded and nitrogen determinations made in the usual way.

In all cases the pots receiving the green rye, and green rye and limestone, show an increased yield over the checks. The yield with the green rye and limestone is, however, in most cases about the same as the yield with the green rye alone. The highest average yield is 35.2 grams with limestone and 100 grams of green rye. The large amount of nitrogen furnished by this quantity of green rye gave a rank growth of plant with slight development of grain. On May the 5th it was noted that plants in pots 22 to 27 were greener than the others and that the heads were little more than chaff and beards.

The average percentage of nitrogen is in all cases higher where green rye is used than it is for the checks, but when ground limestone is applied with the green rye, there is not any decided increase in percentage of nitrogen over those with the green rye alone. Two out of the three that received limetone with the green rye show an increase over the check greater than the increase shown by those that received green rye alone.

While the results secured in this experiment are not so positive as those of Experiment No. 4, there is still evidence that the ground limestone has had a beneficial influence on the decomposition of the organic matter and in making the nitrogen of this available. There appeared to be no essential difference in germination between pots receiving the green rye and the check pots.

THE FORMATION OF CARBON DIOXIDE AND NITRATES IN THE PRESENCE OF LARGE AMOUNTS OF CARBOHYDRATES.

Experiments conducted at this Station[1] have shown definitely that large applications of carbohydrates depress the yield of dry matter and the amount of nitrogen recovered.

Investigators abroad have likewise called attention to this fact, and farmers have occasionally noted that unusually large applications of manure seemed to depress the yield. Explanations have been suggested, but, so far as we know, no positive cause has been assigned. In endeavoring to explain this, it occurred to one of us that the amount of carbon dioxide formed might in some way throw light on this question. It was decided, therefore, to collect and determine the carbon dioxide evolved from a given weight of soil under uniform conditions.

[1]Report of Soil Chemist and Bacteriologist for 1911, pp. 193-312, and report for 1912, pp. 213-233.

To accomplish this 100 grams of moderately acid loam soil were placed in glass tumblers under bell jars, and these bell jars connected on the one side with two bottles containing strong potassium hydroxide and on the other with an Erlenmeyer flask containing a measured quantity of standard barium hydroxide solution. The apparatus was made air-tight and connected with a Chapman filter pump, so that air, freed from carbon dioxide, could be drawn through, thus bringing the carbon dioxide evolved from the soil into the barium hydroxide with the formation of barium carbonate. Before setting up the apparatus, the soil was brought to the optimum moisture condition and one gram of finely ground limestone was thoroughly mixed with each portion. To two of the portions of soil three grams of dextrose were added and to the other two no dextrose was added. The carbon dioxide was determined by titrating the excess of barium hydroxide against standard oxalic acid.

The experiment was continued for 39 days, titrations being made from time to time as the barium hydroxide approached neutrality. For the first two days the evolution of carbon dioxide was very nearly the same from the four portions of soil, but, after the second day, it was evolved very slowly from the two portions which received no dextrose. From the two portions which received dextrose there was a rather rapid and fairly constant evolution of carbon dioxide from the third to the twenty-second day, when the flow was somewhat reduced, though gas had not ceased coming off when the experiment was, for the lack of time, discontinued.

On disconnecting the apparatus the nitrates were determined in the four portions of soil by the colorimetric method.

Nearly ten times as much carbon dioxide was evolved from the portions of soil that received dextrose as from the checks. On the other hand, there was approximately 122 times as much NO_3 in the non-dextrose portions as in the dextrose portions.

The work must be repeated with different amounts and different forms of carbohydrates, and with different types of soil, before conclusive results are had, but the initial results are significant.

Two explanations suggest themselves: either the dextrose in some way inhibits nitrification, or rapid denitrification takes place in the presence of dextrose; or organisms which are aided in their development and multiplication by the presence of the dextrose, build the nitrates into their bodies, making them, in this case, unavailable for detection as nitrates, and in the case of vegetation experiments, making them unavailable for the plants.

The possibility of direct injury to the plants from carbon dioxide evolved seems remote for the reason that such injury does not appear to have been noted in soils very rich in organic matter where large quantities of carbon dioxide would necessarily be evolved, and, further, because, in the pot experiments cited above, the plants did not revive after weeks of growth when the carbon dioxide should have been largely dissipated.

Further work along this line is being conducted.

THE CONTINUOUS GROWING OF WHEAT AND RYE—1914.

The plan of this experiment was fully described in the Annual Report for 1912.* The results for the first five years were given there in detail and a further account appears in the Annual Report for 1913. For convenience, the general plan may be briefly restated.

Plan of Experiment.

The experiment is being conducted on four one-twentieth acre plots, designated as numbers 68, 69, 70, and 71. The soil is a gravelly loam fairly uniform in quality. Previous to starting this experiment the land had been used for general farming, but had not been heavily manured and had not been limed for more than twenty years. When the experiment was begun, all plots were limed at the rate of 2,000 pounds of ground limestone per acre. The plots also receive annually an application of minerals (acid phosphate and muriate of potash) at the rate of 400 pounds of acid phosphate and 200 pounds of muriate of potash per acre. No nitrogenous fertilizers are used. Tests made of samples of soils collected from these plots in the spring of 1913 show a lime requirement of four to six hundred pounds of lime (CaO) per two million pounds of soil. In the fall of 1913, before seeding to wheat and rye, they received limestone at the rate of 4,000 pounds per acre.

The arrangement of plots, with the treatment given, is as follows:

Plot 68, Rye alone	Minerals
Plot 69, Wheat alone	Minerals
Plot 70, Rye followed each year with Cow Peas (or Soy Beans) as green manure	Minerals
Plot 71, Wheat followed each year with Cow Peas (or Soy Beans) as green manure	Minerals

Each year the stubble is disked on Plots 70 and 71 soon after harvesting the crop, and soy beans are drilled in. Plots 68 and 69 remain in stubble. About two or three weeks before seeding to wheat and rye, the green manure crop on Plots 70 and 71 is turned under and Plots 68 and 69 are also prepared for seeding. On account of cow pea wilt in the soil, Ito San soy beans were substituted for the cow peas on Plots 70 and 71 in the fall of 1913. At the time of plowing under the soy beans, September 8, it was noted that they were about 15 inches high, and that there was an even stand and fair inoculation. On September 24 the plots were further prepared, mineral fertilizers applied and seeded to rye and wheat in accordance with the plan.

Crop for 1914.

As was the case last year so again this year the yields of both rye and wheat were unduly low. However, it is to be noted that the yield on the legume plots is decidedly in excess of that on the non-legume plots.

The yield of rye grain is nearly one-fourth more, and the yield of wheat grain more than doubled. The yield of wheat straw on the legume plots is also more than double that on the non-legume plots.

*Report Soil Chemist and Bacteriologist, N. J. Agri. College Expt. Sta. 1912, p. 261.

PLATE I.

PLOT No. 68.—Continuous Rye. No. Nitrogen Supplied.

PLOT No. 70.—Continuous Rye. Nitrogen Supplied by Leguminous Crop Grown Each Year After Harvesting the Rye.

The percentage of nitrogen is higher in the rye, both grain and straw, from the legume plots than from the non-legume plots. In the case of the wheat it is practically the same in both. While the yields are not what they should be it is clear that the leguminous crops are responsible for substantial gains in grain and straw and in amount of nitrogen recovered. The nitrogen recovered with rye alone is at the rate of 19.44 lbs. per acre, and with rye followed by the legume it is at the rate of 26.56 lbs. per acre. With the wheat the nitrogen recovered from the legume plot is more than double that from the non-legume plot.

With thicker seeding of the soy beans and by selecting a variety with a more luxuriant growth, as for example the Swan, it will unquestionably be possible to materially increase the yields of grain and straw and, therefore, the amount of nitrogen accumulated.

Table I—Rye and Wheat with and without Legumes, 1914.
(1-20 Acre Plots)

Plot No.	CROP.	Grain per plot.			Straw per plot.			Per acre.		
		Dry Matter lbs.	Per cent. nitro'n	Nitrogen lbs.	Dry matter lbs.	Per cent. nitro'n	Nitrogen lbs.	Grain bushels	Straw lbs.	Nitrogen lbs.
68	Rye alone	46.0	1.466	.674	92.0	.324	.298	16.43	1840	19 44
69	Wheat alone	18.0	1.972	.355	36 0	.578	.208	6.00	720	11.26
70	Rye followed by Soy Beans	54.0	1.542	.833	138.0	.359	.495	19.29	2760	26.56
71	Wheat followed by Soy Beans	40.0	1.963	.785	78.0	.570	.445	13.33	1560	24.60

THE INFLUENCE OF BACTERIA IN MANURE ON THE DECOMPOSITION OF GREEN MANURE. (LEGUME AND NON-LEGUME.

An account of the first five years of this work was given in the report for 1912, and an account of the work for 1913 in the report for that year. The object of the experiment is to study the bacterial influence of cow manure on the decomposition of green manures. The quantities of manure are purposely kept small in order that the influence of the fertilizing constituents in the manure may be reduced to a minimum. The experiment also contemplates a comparison of legumes with non-legumes in continuous corn growing.

For convenience a brief statement of the plan is included here.

Plan of the Experiment.

"The experiment is conducted on one-twentieth acre plots, on land that is largely a gravelly loam, varying from sandy to clayey phases, although apparently the differences are not great. The soil is not what would be called a fertile soil, and is without doubt deficient in nitrogen, this being the chief limiting factor. At the beginning of the experiment ground limestone, at the rate of one ton per acre, was applied to all the plots by means of a fertilizer drill, and each plot also received fifteen pounds of

acid phosphate, five pounds of potassium chloride, and ten pounds of dried fish. The special treatment is as follows:

Plot 49, corn followed by crimson clover as green manure, no cow manure.
Plot 50, corn followed by crimson clover as green manure, + 50 lbs. manure.
Plot 51, corn followed by crimson clover as green manure + 100 lbs. manure.
Plot 52, corn followed by crimson clover as green manure + 200 lbs. manure.
Plot 53, corn followed by rye as green manure, no cow manure.
Plot 54, corn followed by rye as green manure, + 50 lbs. cow manure.
Plot 55, corn followed by rye as green manure, + 100 lbs. cow manure.
Plot 56, corn followed by rye as green manure, + 200 lbs. cow manure.

The manure is preferably that which has been well rotted, and is broadcasted over the green manure before plowing under."

Crop of 1914.

The crimson clover and vetch which were seeded in the corn, Plots 49-52, in the fall of 1913 did not make a satisfactory growth. It is very hard for these crops to get a start while the corn is growing, especially if the weather is dry.

The following notes were made May 11, 1914:

Plot 49, Crimson Clover in scattered clumps, no vetch; poorest of crimson clover.
Plot 50, Clover scattered, better than plot 49. No vetch.
Plot 51, Better than plot 50. No vetch.
Plot 52, Same as plot 51.

On the same date the following notes were made with reference to the rye:

Plot 53, Rye knee deep; poorest of rye plots.
Plot 54, Better than 53.
Plot 55, Same as plot 54.
Plot 56, Rye not so good as on 54. Better than 53.

As in previous years the cow manure was spread over the green manure crops and all plowed under about the middle of May. The plots received fifteen pounds of acid phosphate and five pounds of muriate of potash and were prepared for planting. On May 16 they were planted to Reed's Yellow Dent Corn, which received the usual cultivation. On August 4 cover crops were seeded in the corn as follows: Plots 49-52 crimson clover, vetch and soy beans; and Plots 53-56 rye. These, however, made very poor growth on account of the unusually long period of dry weather. The soy beans were a complete failure. Plots 49-52 were inoculated for soy beans and vetch. On September 25 the corn was harvested and after being partially dried one-twentieth of the entire weight from each plot was taken as a sample and after further drying was prepared for analysis in the usual way. The yield of dry matter, percentage of nitrogen and other data are shown in Table II.

Table II—Corn 1914.
(Calculated to Acre basis)

Number	TREATMENT.	GRAIN.		STALKS.		COBS			INCREASE OVER CHECK.		
		Dry matter bu.	Per cent nitrogen	Dry matter lbs.	Per cent nitrogen	Dry matter lbs.	Per cent nitrogen	Total nitrogen lbs.	Dry matter grain bu.	Dry matter stover lbs.	Total nitrogen lbs.
					LEGUME SECTION.						
49	No manure.	30.71	1.273	2800	0 698	280	0.401	42 563	. . . .	. . .	. .
50	50 lbs cow manure	38.57	1.421	3400	0 602	360	0 401	52.604	7 86	680	10.041
51	100 lbs. cow manure	36 43	1.369	3560	0 602	360	0 392	50.770	5 72	840	8.207
52	200 lbs cow manure	36 79	1.299	3120	0 715	320	0 366	50.238	6 08	360	7 675
					NON-LEGUME SECTION.						
53	No manure. . .	20 00	1 256	2720	0.558	200	0 436	30.117	. .		
54	50 lbs. cow manure .	29 64	1 378	3040	0 576	300	0.419	41.542	9.64	420	11.425
55	100 lbs. cow manure	34.29	1 317	3200	0 576	320	0.419	45.059	14 29	600	14.942
56	200 lbs. cow manure	28 57	1.360	2600	0 654	280	0 401	39.887	8 57		9.770

The results are calculated to the acre basis, and the grain is reported in bushels, while the stover and nitrogen are reported in pounds.

The Influence of the Manure.

An examination of the table shows that with but one exception the yield of dry matter—grain, straw and cobs—is higher on the plots that receive manure than on the check plots. As pointed out in previous reports this increase cannot be attributed to the fertilizing constituents in the manure for the reason that it frequently happens that the increase is greater on the plots that receive 50 or 100 pounds of manure than on those that receive 200 pounds. Likewise the percentage of nitrogen in the grain is higher in all plots that receive manure than in the check plots. This, however, does not hold true for the stalks and cobs, for with these the nitrogen runs fairly constant.

The total nitrogen recovered in the crop is invariably higher on the manured than on the unmanured plots, but here again larger yields are noted with 50 and 100 pounds per plot than with 200 pounds per plot.

The Legume and Non-legume Sections Compared.

As we should expect, the yields on the legume section are always higher than on the non-legume section and in the grain the percentage of nitrogen is also higher. This is not always true of the stalks and cobs, but the total yield of nitrogen is in every case higher on the legume than on the non-legume plots.

On the contrary the increase over the check, both grain and nitrogen is greater for the non-legume plots than for the legume plots. This is unquestionably due to the fact that the check plot in the legume section is able to utilize atmospheric nitrogen and thus approach more nearly to the

nitrogen yield of the other plots in that section, an advantage which the check plot in the non-legume section does not have.

From the data here reported there seems to be good reason for believing that the bacteria conveyed in small quantities of manure do have a beneficial effect in the decomposition of the green manure crops. When the green manure crop is a legume, the additional nitrogen thus secured tends to obscure the effects of the manure. Certainly the legume is more effective in increasing the yield and also in maintaining the nitrogen supply of the soil than the non-legume, and there is good ground for believing that the nitrogen in the former is more available than in the latter.

THE INFLUENCE OF THE MECHANICAL COMPOSITION OF THE SOIL ON THE AVAILABILITY OF NITRATE OF SODA AND DRIED BLOOD.

This is a continuation of work that was begun in the spring of 1911, and the results for 1911, 1912 and 1913 have already been published.* For convenience, a diagram showing the plan of the experiment, together with a brief description, as presented in previous reports, are herewith submitted.

"The soil used was the typical red shale that had not been under cultivation. This was screened to remove stones, and was then mixed with sand in varying proportions as indicated in the accompanying diagram. The soil was then placed in cylinders of the type that has been in use at this Station for a number of years,† and to each cylinder there were added 38 gms. of precipitated chalk, 20 gms. acid phosphate, 5 gms. potassium chloride, 5 gms. potassium sulphate and 2 gms. magnesium carbonate. As originally planned the five-year rotation included corn, oats, wheat and timothy. Later it was decided to substitute barley for oats, consequently the 1912 crop was barley with buckwheat as a residual crop. Each group of six cylinders is set off in three pairs, and each of the three pairs of a group receives a different fertilizer treatment, which treatment, however, is common to all groups. Thus the first and second cylinders of any group receive no fertilizer, the third and fourth receive ten gms. of nitrate of soda and the fifth and sixth dried blood equivalent to ten gms. of nitrate of soda."

*Reports of Soil Chemist and Bacteriologist, New Jersey Agricultural College Experiment Station, 1911, 1912 and 1913.

†Bul. 221, N. J. Expt. Sta.

Plan of Experiment.

Series	Arrangement of Cylinders.			Soil.	Treatment.
A	1	2	3	Shale soil	1, 2, nothing. 3, 4, 10 gms. nitrate soda. 5, 6, 13.39 gms. dried blood.
	4	5	6		
B	1	2	3	10% sand	"
	4	5	6		
C	1	2	3	20% "	"
	4	5	6		
D	1	2	3	30% "	"
	4	5	6		
E	1	2	3	10% "	"
	4	5	6		
F	1	2	3	50% "	"
	4	5	6		
G	1	2	3	70% "	"
	4	5	6		
H	1	2	3	80% "	"
	4	5	6		
I	1	2	3	90% "	"
	4	5	6		
J	1	2	3	100% "	"
	4	5	6		

First Crop—Barley, 1914.

The cylinders remained bare during the winter of 1913-14 and were prepared and seeded to barley early in May.

The fertilizer treatment was the same as in previous years, and 38 grams of non-magnesian limestone and 2 grams of magnesium carbonate were applied to each cylinder. The barley made an average growth and was harvested about the last of July, dried, weighed and samples prepared for analysis in the usual way. The dry weights and other analytical data are given in Table III.

Table III—Barley—1914.

Series		Nitrogen applied grms	Dry matter grams. Per cylinder.	Dry matter grams. Average	Per cent nitrogen.	Nitrogen grams. Per cylinder.	Nitrogen grams. Average.	Nitrogen increase over check, grams	Per cent nitrogen recovered.	Relative availability.
A	1	Nothing	58.5	50.25	1.104	.646	.574			
	2		42.0		1.192	.501				
	3	1.54	70.5	94.50	1.586	1.118	1.338	.764	49.61	100.00
	4		118.5		1.314	1.557				
	5	1.54	65.0	65.10	1.472	.957	.905	.331	21.49	43.3
	6		65.2		1.306	.852				
B	1	Nothing	55.5	54.75	1.087	.603	.619	...		
	2		54.0		1.174	.634				
	3	1.54	107.0	100.00	1.481	1.585	1.510	.891	57.86	100.00
	4		93.0		1.542	1.434				
	5	1.54	106.2	100.60	1.332	1.415	1.345	.726	47.14	81.5
	6		95.0		1.341	1.274				
C	1	Nothing	42.0	42.25	1.165	.489	.492			
	2		42.5		1.165	.495				
	3	1.54	110.5	93.10	1.411	1.559	1.297	805	52.28	100.00
	4		75.7		1.367	1.035				
	5	1.54	86.3	83.40	1.200	1.036	1.019	527	34.22	65.45
	6		80.5		1.244	1.001				
D	1	Nothing	37.0	37.75	1.165	.431	.437			
	2		38.5		1.148	.442				
	3	1.54	114.4	109.65	1.279	1.463	1.430	993	64.48	100.00
	4		104.9		1.332	1.397				
	5	1.54	92.0	82.45	1.323	1.217	1.100	663	43.05	66.76
	6		72.9		1.349	.983				
E	1	Nothing	40.2	38.10	1.078	.433	.409		......	......
	2		36.0		1.069	.385				
	3	1.54	115.0	108.00	1.271	1.462	1.430	1.021	66.30	100.00
	4		101.0		1.384	1.398				
	5	1.54	85.0	81.85	1.157	0.983	1.012	.603	39.16	59.07
	6		78.7		1.323	1.041				
F	1	Nothing	43.0	42.25	1.052	.452	.448			
	2		41.5		1.069	.444				
	3	1.54	112.2	111.35	1.218	1.367	1.371	923	59.94	100.00
	4		110.5		1.244	1.375				
	5	1.54	88.7	91.45	1.252	1.111	1.146	698	45.32	75.63
	6		94.2		1.252	1.181				
G	1	Nothing	34.4	33.05	1.016	.350	.328			
	2		31.7		.964	.306				
	3	1.54	120.0	121.25	1.139	1.367	1.424	1.096	71.17	100.00
	4		122.5		1.209	1.481				
	5	1.54	99.5	103.25	1.174	1.168	1.175	.847	55.00	77.28
	6		107.0		1.104	1.182				
H	1	Nothing	26.0	28.15	.990	.257	.284	......		
	2		30.3		1.025	.311				
	3	1.54	113.2	115.60	1.087	1.230	1.319	1.035	67.21	100.00
	4		118.0		1.192	1.407				
	5	1.54	106.5	100.25	1.148	1.223	1.151	.867	56.30	83.9
	6		94.0		1.148	1.079				
I	1	Nothing	16.5	18.45	1.192	.197	.213	......	....	....
	2		20.4		1.122	.229				
	3	1.54	102.0	108.20	1.130	1.153	1.193	980	63.64	100.00
	4		114.4		1.078	1.233				
	5	1.54	86.7	86.95	1.192	1.033	1.021	808	52.47	82.5
	6		87.2		1.157	1.009				
J	1	Nothing	8.0	8.75	1.157	.093	.109	.....	..	......
	2		9.5		1.314	.125				
	3	1.54	98.5	79.15	1.130	1.113	1.020	811	52.67	100.00
	4		59.8		1.551	.927				
	5	1.54	73.5	67.60	1.113	.818	.801	.692	44.93	85.3
	6		61.7		1.271	.784				

With the exception of Nos. 3 and 4 in series "A," "C" and "J," the duplicates are in very fair agreement. The highest average yield is 121.25 grams with nitrate of soda in series "G," where the mixture is 70 per cent. sand, and the next highest is 115.6 grams with nitrate of soda in series "H," 80 per cent. sand. However, cylinder No. 4 in series "A," pure shale, gave a yield of 118.5 grams. With one exception only, that of series "B," nitrate gave a higher yield than dried blood. In previous years we have found a higher yield of dry matter with dried blood than with nitrate in cylinders having 80 to 100 per cent. of sand, but it is not so with this crop. The average yield for the check cylinders is invariably lower than for either the dried blood or nitrate treatment.

In series "A," "B" and "C," the percentage of nitrogen is higher for those cylinders that receive nitrate than for those that receive dried blood. For the remaining series the percentage of nitrogen for the two treatments runs very nearly the same. With one exception only, the average percentage of nitrogen for the check cylinders is less than the average for either dried blood or the nitrate treatment. The percentages of nitrogen are, on an average, higher for series "A," "B," "C" and "D" than for the remaining series. Whether this is due to the heavier soil, that is, soil containing higher percentages of shale, or whether it is accidental, is not clear. It does not appear to have been so in previous years. The highest yield of nitrogen for a single cylinder, 1.585 grams, occurs with nitrate of soda in series "B," which is 10 per cent. sand, and it is also the nitrate treatment of this series that gives the highest average. The percentage of nitrogen recovered is in every case higher with nitrate of soda than with dried blood. It is of interest to note that the highest recovery is in series "G," with 70 per cent. of sand, and the next highest in series "H," with 80 per cent. of sand. These recoveries, 71.17 and 67.21 respectively, are a close approach to recoveries that have been secured in many of the pot experiments conducted at this Station. The highest recoveries with dried blood are likewise in these same series, and these are above the recoveries usually obtained in pot experiments. The lowest recovery for both nitrate and dried blood occurs in series "A." This may no doubt be attributed to poor physical condition, due largely to a deficiency of organic matter.

The average of all series for nitrate of soda is 60.516 and for dried blood 43.918. These figures agree quite closely with the ten-year averages obtained in the cylinder experiments* with loam soil.

If we place the average availability for nitrate at 100, then the average availability for dried blood will be 72.07. It may be pointed out that, on the basis of 100 for nitrate of soda, the average availability for dried blood in series "H," "I" and "J" is 83.9, while, on the same basis, the average availability for series "A" to "G," inclusive, is 67. This again points to a higher availability for dried blood than for nitrate in sand or very sandy soil.

In no one of the combinations of sand and soil, or pure soil and sand, does the dried blood show an availability equal to that of the nitrate of

*Bulletin 221 New Jersey Agricultural College Experiment Station.

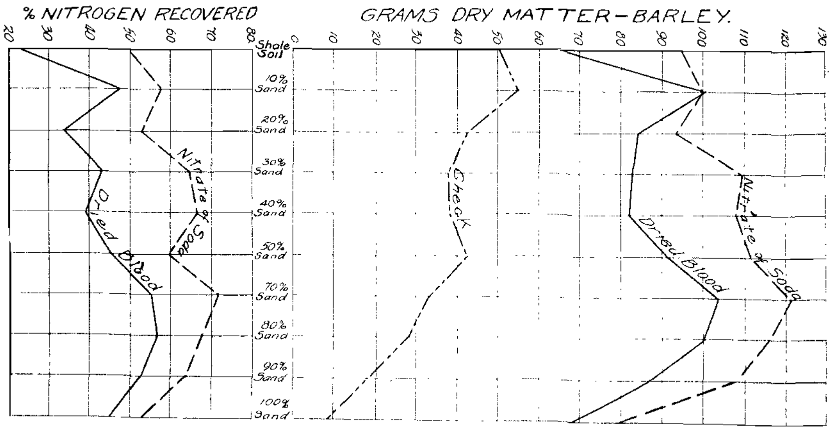


FIGURE 1.—Weight of Dry Matter and Per Cent. Nitrogen in First Crop—Barley.

soda. When this is true, there seems little excuse for the farmer to pay more for nitrogen in organic materials than in the form of nitrate.

The relative yields of dry matter and percentage of nitrogen recovered for the different treatments are indicated by curves in Fig. 1.

Residual Crop of Buckwheat, 1914.

Following the barley, the cylinders were prepared and seeded to buckwheat without additional fertilizer, with the intention of utilizing, to the fullest extent possible, the nirogen that was applied to the first crop. The buckwheat was harvested October 1st, dried and weighed and samples prepared for analysis. The results are given in Table IV.

Table IV—Residual Crop of Buckwheat, and Summary for both Crops 1914.

Series No.		Residual crop. Dry matter grams. Per cylinder.	Average.	Per cent. nitrogen.	Nitrogen per cylinder.	Grams, average.	Nitrogen increase over check gms.	Residual nitrogen recovered. Per cent.	Both crops. Nitrogen increase over check grams.	Per cent. nitrogen recovered.	Relative availability.	Total nitrogen grams.	Total dry matter grams.
A	1	21.5	28.00	1.612	.347	.447	...	...	...	...	...	1.021	78.25
	2	34.5		1.586	.547								
	3	24.0	24.00	1.937	.465	.465	.018	1.17	.782	50.78	100	1.803	118.50
	4	*2.5		2.015	*.050								
	5	34.7	33.95	1.901	.660	.668	.221	14.35	.552	35.84	70.6	1.573	99.05
	6	33.2		2.033	.675								
B	1	32.0	26.00	1.612	.516	.441						1.060	80.75
	2	20.0		1.823	.365								
	3	15.0	18.85	1.980	.297	.385			.891	57.86	100	1.895	118.85
	4	22.7		2.085	.473								
	5	25.0	25.00	1.875	.469	.492	.051	3.31	.777	50.45	87.2	1.837	125.60
	6	25.0		2.059	.515								
C	1	8.5	11.75	1.963	.167	.209						.701	54.00
	2	15.0		1.674	.251								
	3	23.0	27.50	1.717	.395	.513	.304	19.74	1.109	72.02	100	1.810	120.60
	4	32.0		1.972	.631								
	5	30.7	33.60	1.910	.586	.586	.377	24.48	.904	58.70	81.5	1.605	117.00
	6	36.5		1.604	.585								
D	1	20.5	19.75	1.525	.313	.308						.715	57.50
	2	19.0		1.595	.303								
	3	24.0	24.00	1.717	.412	.405	.097	6.30	1.090	70.78	100	1.835	133.65
	4	24.0		1.656	.397								
	5	13.5	21.25	2.234	.302	.392	.084	5.45	.747	48.50	68.5	1.492	103.70
	6	29.0		1.658	.481								
E	1	20.7	22.60	1.584	.328	.362						.771	60.70
	2	24.5		1.612	.395								
	3	21.5	24.75	1.674	.360	.405	.043	2.79	1.064	69.09	100	1.835	132.75
	4	28.0		1.604	.449								
	5	34.3	33.90	1.551	.532	.561	.199	12.92	.802	52.08	75.4	1.573	115.75
	6	33.5		1.761	.590								
F	1	30.5	28.10	1.384	.422	.402				...	...	.850	70.35
	2	25.7		1.481	.381								
	3	28.5	33.35	1.639	.467	.518	.116	7.53	1.039	67.47	100	1.889	144.70
	4	38.2		1.490	.569								
	5	45.8	34.80	1.568	.718	.550	.148	9.61	.846	54.93	81.4	1.696	126.25
	6	23.8		1.604	.382								
G	1	19.0	20.50	1.384	.263	.275				...	...	.603	53.55
	2	22.0		1.304	.287								
	3	18.5	18.85	1.455	.269	.271			1.096	71.17	100	1.695	140.10
	4	19.2		1.420	.273								
	5	27.0	27.25	1.455	.393	.393	.118	7.66	.965	62.66	88.0	1.568	130.50
	6	27.5		1.428	.393								
H	1	22.7	21.35	1.384	.314	.297			...	...	...	.581	49.50
	2	20.0		1.393	.279								
	3	15.0	19.50	1.472	.221	.292			1.035	67.21	100	1.611	135.10
	4	24.0		1.507	.362								
	5	30.0	29.10	1.358	.407	.484	.187	12.14	1.054	68.44	101.8	1.635	129.35
	6	28.2		1.490	.561								
I	1	16.0	15.75	1.332	.213	.228	...	...	...	...	...	.441	34.20
	2	15.5		1.568	.243								
	3	15.5	15.50	1.507	.234	.243	.015	0.97	.995	64.61	100	1.436	123.70
	4	15.5		1.621	.251								
	5	25.0	24.00	1.744	.436	.389	.161	10.46	.969	62.93	97.4	1.410	110.95
	6	23.0		1.481	.341								
J	1	4.5	6.5	1.910	.086	.116	...	...	...	...	...	.225	15.25
	2	8.5		1.717	.146								
	3	6.0	6.0	1.709	.103	.104	...	...	.811	52.67	100	1.124	85.15
	4	6.0		1.753	.105								
	5	19.3	16.4	1.639	.316	.274	.158	10.26	.850	55.19	104.8	1.075	84.00
	6	13.5		1.717	.232								

*Omitted from average.

The residual crop is much smaller than the first crop, but, with few exceptions, the duplicate weights agree well. With one exception, that of series "D," the yield of dry matter with dried blood is greater than with nitrate of soda. For the years 1912 and 1913 this was true without exception. The yield from the check cylinders is greater than that from the nitrate cylinders in six out of ten series, though, in most cases, the differences are not great one way or the other. The explanation for the higher yield with the residual crop on the check cylinders seems to be found in the fact that the first crop not only uses up the nitrate that is applied to these cylinders, but, on account of stimulated growth, the plants are enabled to more thoroughly utilize the organic nitrogen of the soil and thus these cylinders are left in a more depleted condition with reference to supply of nitrogen than the check cylinders. This point was explained more fully in the report for 1913.

It is thus quite clear that one cannot depend upon the initial application of nitrate of soda to maintain the crop yield and nitrogen supply of the soil if a residual crop is to be grown. Either a second application of nitrate must be made or the second crop must be a legume. Neither does the initial application of dried blood prove sufficient to maintain the yield for a second crop, though, on account of its lower efficiency with the first crop, it may give higher yields than the nitrate with the second crop.

The highest yield, 34.8 grams, occurs with dried blood in series "F," with 50 per cent. of sand, and the next highest, 33.95 grams, with dried blood in series "A," pure shale, and the next with dried blood in series "E," with 40 per cent. sand. The lowest yield, 6 grams, is with nitrate of soda in series "J," pure sand, and the next lowest, 6.5 grams, with nitrate also in series "J." The highest average for any one series is 32.08 grams for series "F" and the next highest, 28.64 grams, for series "A." In this connection it may be remembered that the yield of barley for series "A" was unusually low.

The percentage of nitrogen in the buckwheat is distinctly higher than in the barley of the first crop. It will further be noted that the percentages run considerably higher in series "A," "B," "C" and "D," on an average, than in the remaining series, and this was also noted in connection with the barley.

The highest yield of nitrogen, 0.668 grams, occurs with dried blood in series "A," pure shale soil, and the next highest, .586, with dried blood in series "C," 20 per cent. sand.

The highest recoveries for both nitrate and dried blood occur in series "C," the recovery for nitrate being 19.74 per cent. and for dried blood 24.48 per cent. With the exception of this series, the recoveries for nitrate are small, or there is no recovery for this material, thus showing in most cases a high relative availability for dried blood in the residual crop.

A summary for the two crops shows an average recovery for nitrate of 64.366 per cent. and for blood of 54.97 per cent. The average availability for blood, when nitrate is taken at 100, is 85.66. The average total nitrogen for both crops is .70 gram for the check cylinders, 1.693 grams for the

nitrate cylinders, and 1.546 grams for the dried blood cylinders. The highest amount of nitrogen *recovered for both crops is* 1.895 *grams* with nitrate of soda in series "B," with 10 per cent. of sand, and the next highest is 1.889 grams with nitrate of soda in series "F," 50 per cent. sand.

The yields of dry matter for the residual crop, and the yields of dry matter and percentage of nitrogen recovered, for the combined crops, are indicated by curves in Figs. 2 and 3 respectively.

The Theoretical and Actual Recoveries from the Shale Soil.

As in previous years a comparison of the amount of nitrogen which should be recovered from the organic matter of the shale soil where sand was introduced (as calculated from the recovery from pure shale), with the net amount actually recovered, is of interest.

Under "Total Nitrogen in Both Crops" it is seen that there was recovered from the check cylinders 1.021 gms. From the corresponding cylinders with pure sand there was a recovery of 0.225 gm. made up of traces which may have been in the sand, that which was contained in the seed, and any that may have been fixed by non-symbiotic hacteria. The difference between these amounts, 0.796, represents the actual net recovery from the shale soil cylinders.

Since the check cylinders of series "B" were 90 per cent. shale instead of pure shale the theoretical recovery from this should be 90 per cent. of 0.796, which is 0.716. The actual amount of nitrogen recovered in the combined crops from the check cylinders of series "B" was 1.060 gms. and subtracting from this 0.225 gm. (combined recovery from check cylinders in pure sand), we have 0.835 gm., which represents the net recovery from the shale soil of series "B." In a similar way we may calculate the theoretical and actual recoveries from the humus of the shale soil for the combined crops with various dilutions. These results are shown in Table V.

Table V—Nitrogen Recovered from Shale Soil in the Combined Crops.

COMPOSITION OF THE SOIL.	Theoretical Amount of Nitrogen Recovered. Gms.	Actual Amount of Nitrogen Recovered. Gms.
100 % Shale Soil	.796	.796
90 % " "	.716	.835
80 % " "	.637	.476
70 % " "	.557	.520
60 % " "	.478	.546
50 % " "	.398	.625
30 % " "	.239	.378
20 % " "	.159	.356
10 % " "	.079	.216
100 % sand.		

From this table we note that with two exceptions, namely, 80 and 70 per cent. of shale soil, the actual recoveries surpass the theoretical amounts as calculated from the recovery from the shale soil alone. It may be pointed out that the amount thus actually recovered is decidedly increased with the higher percentages of sand.

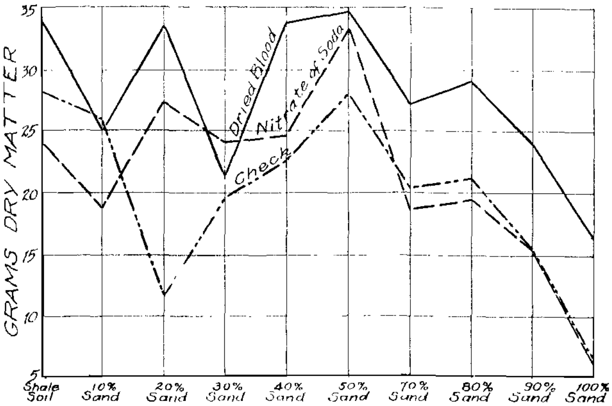


FIGURE 2.—Weight of Dry Matter in Residual Crop—Buckwheat.

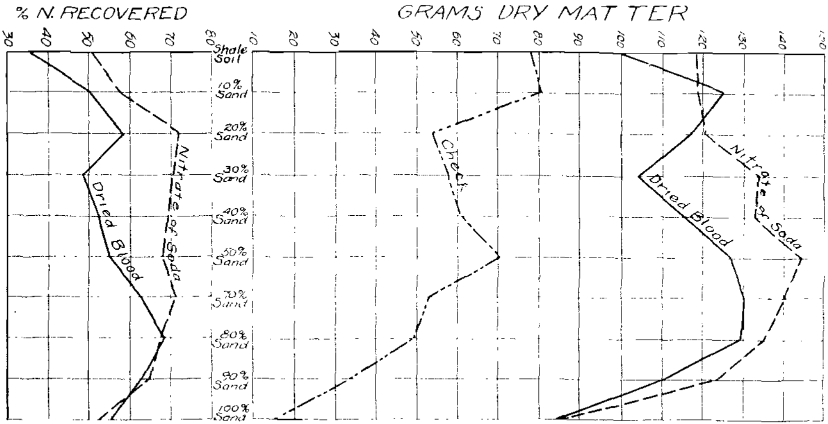


FIGURE 3. Weight of Dry Matter and Per Cent. Nitrogen Recovered in Both Crops.

As pointed out in previous reports this clearly indicates an improved condition of the soil with the introduction of sand, due to better aeration, and therefore more complete utilization of the soil organic matter.

Summary.

1. This is a continuation of work begun in 1911 on the availability of nitrate of soda and dried blood when applied to shale soil and mixtures of sand and shale soil.

2. Nitrate of soda and dried blood when used on mixtures of sand and shale soil varying in proportion from 10 per cent. to 90 per cent. sand, give higher yields of dry matter and nitrogen in the first crop than when used with loam soil alone or sand alone.

3. With the first crop nitrate invariably gave higher yields than dried blood.

4. The average recovery of nitrogen with nitrate of soda for the first crop was 60.52 per cent., and with dried blood 43.92 per cent. The highest recovery with nitrate of soda was 71.17 per cent. where the mixture contained 70 per cent. of sand, and the highest recovery for dried blood was 56.3 per cent. with 80 per cent. sand.

5. Taking 100 as the availability of the nitrate of soda for this crop the availability of the dried blood was 72.07.

6. With the residual crop of buckwheat the yields from the check cylinders were in a number of cases larger than from the nitrate cylinders. This is apparently due to the fact that the nitrate was largely utilized by the first crop thus stimulating the crops of these cylinders to a more thorough utilization of the soil organic nitrogen than was possible on the check cylinders; therefore the check cylinders have as much available nitrogen and possibly more for the second crop than the nitrate of soda cylinders.

7. In four out of the ten series no nitrate nitrogen was recovered in the second crop and, with one exception, the recoveries from the other six were low. The average residual recovery from dried blood for all series was 11.05 per cent.

8. Notwithstanding this high recovery from dried blood with the residual crop, when the combined recoveries are considered the nitrate stands ahead in all series except "J," where sand alone was used. The average combined recovery is 64.37 per cent. for the nitrate of soda and 54.97 for dried blood.

9. With the combined crops the dried blood shows an availability of 85.66 when nitrate of soda is taken at 100.

10. From these results it is quite clear that we need not expect much residual effect from a moderate application of nitrate of soda. We may expect some residual effect from dried blood in nearly all cases, though the initial effect of nitrate is sufficiently above that of the dried blood to place the nitrate ahead when the combined recoveries are considered.

11. With these facts before him it would seem that the farmer could not afford to pay more for nitrogen in organic materials than in nitrate of soda.

12. Mixing sand with heavy soils permits a better aeration and drainage and results in a more complete utilization of the nitrogen of the soil organic matter.

THE INFLUENCE OF LIME ON THE YIELD OF DRY MATTER AND PERCENTAGE OF NITROGEN.

Earlier experiments* have shown that with acid soils lime not only increases the amount of dry matter but that it also increases the percentage of nitrogen in the dry matter. This experiment was planned to give further data in this connection with especial reference to leguminous crops.

The soil was a sandy loam containing some gravel and having a lime requirement of about 2,000 pounds per acre 6 2-3 inches.

Pots holding 18 pounds of soil were used, and all received 4 grams acid phosphate and 2 grams potassium sulphate. In addition to the general treatment, certain of the pots received ground limestone as indicated in the table, while three received nitrate of soda for comparison. The moisture was maintained at about 12 per cent. until the crop grew so large that it was impossible to regulate the supply accurately. The pots were seeded to Crimson Clover December 29 and this grew until it was about 18 inches high, and was in full bloom. It was then harvested, dried and weighed as usual. The yield of dry matter and nitrogen, together with other data are shown in Table VI.

*Field Experiments on the Availability of Nitrogenous Fertilizers, Lipman and Blair, Bulletin No. 260, N. J. Agri. Expt. Sta. pp. 11-12.

PLATE A.

CaCo NaNo Check CaCo $NaNo_3$ Check

Vetch and Barley on an Acid Soil. Lime Aids in Making the Nitrogen of the Soil Organic Matter Available.

Table VI—The Yield of Dry Matter and Nitrogen as Influenced by Lime—Leguminous Crops.

		FIRST CROP—CRIMSON CLOVER 1913-14.				RESIDUAL CROP—SOYBEANS 1914.			
Pot number.	SPECIAL TREATMENT.	Dry matter gms.	Per cent. nitrogen.	Average nitrogen mgs.	Per cent. increase over check, nitrogen	Dry matter gms.	Per cent. nitrogen.	Average nitrogen mgs.	Per cent increase over check. nitrogen.
1		28.8	1.697			10.0	1.552		
2	No lime (check)	24.1	1.707	437.24		11 7	1.639	149.35	
3		22.2	1.854			7.2	1.404		
4		35.5	1.844			7.7	1.491		
5	2 gms. nitrate of soda	30.9	1.727	564.21	29.04	7.2	1.264	116.21	
6		28.4	1.776			9.4	1.413		
7		42.6	2.119			28.0	2 808		
8	10 gms. ground limestone	36.2	2.099	811.94	85.69	17.2	2.197	473 94	217 33
9		36.0	2.148			15.5	1.727		
10		39.7	2.070			25.0	2 006		
11	25 gms. ground limestone	38.0	2.237	812.28	85.77	21.2	1.997	458.08	206.71
12		37.5	2.040			24.2	1.857		
13		33.0	2.139			25.5	2.197		
14	50 gms. ground limestone	37.7	2 227	765.78	75.14	27.0	2.032	524.27	251.04
15		36.5	2.060			28 0	2.014		
16		38.4	2.060			27.5	2.163		
17	100 gms. ground limestone	36.8	2.217	794.15	81.63	23.0	2.049	574.68	284.79
18		36.6	2.119			25.7	2.171		

In all cases where lime was used the average yield of dry matter is at least 10 grams more than where no lime was used. The difference in yield with 10 grams and 100 grams of limestone is not great, the highest yield being with 25 grams. Also the yield is higher with 2 grams of nitrate of soda than on the check. The percentage of nitrogen is likewise distinctly higher with lime than without, the average for no lime being 1.75 per cent. and the average with lime being, in all cases, more than 2 per cent. The highest yield of nitrogen, as of dry matter, is with 25 grams of limestone. It is of interest to note that while the nitrate of soda has given an increased yield of nitrogen, over the check, of 29.04 per cent. with lime, the increased yields over check amount to 75 to 85 per cent.

Residual Crop.

Following the crimson clover, soy beans were seeded in the pots without further addition of fertilizers or lime. The beans were seeded about the 1st of June and harvested the 4th of September. The pods had fully formed at this time, but seeds had not ripened so that stalks and pods were harvested together as forage. The dry weights, percentage of nitrogen, and other data are shown in the table above. Here the limed pots show more than double the yield of dry matter given by the check pots, while the nitrate of soda pots yielded less than the check. The highest yield in this case is with 50 grams of limestone and the next highest with 100 grams.

While the percentage of nitrogen is not quite so high as in the preceding crop of clover, it is still higher in the limed than in the unlimed pots, the average of the latter being 1.54 per cent., while the former, with slight exception, show more than 2 per cent. of nitrogen. The average percentage with nitrate of soda is even less than for the check. The highest yield of nitrogen is with 100 grams of limestone. In all cases where limestone was used the increase of nitrogen over the check, as shown by the yield, amounts to more than 200 per cent., and where 100 grams of limestone were used it amounts to nearly 300 per cent.

Should the use of lime in this way result in depleting the nitrogen supply of the soil—and this is undoubtedly what would happen with the growing of non-leguminous crops only—it would finally mean ruined and abandoned farms, *but if leguminous crops are frequently introduced* in the rotation, or better, if the main crop of the rotation is followed by a legume as often as possible, the liberal use of lime will not only mean increased yields, but also increased feeding value as shown by the higher nitrogen content, which means higher protein content.

If to secure this higher protein content one must rely upon commercial nitrogenous materials, the increase may not always prove profitable, but where it can be secured through the growing of leguminous crops, which take their nitrogen largely from the air, it means increased feeding value without increased cost. The fact that the gain in nitrogen over the check, with the residual crop is much greater than with the first crop indicates clearly that the soil is not being exhausted, but rather that nitrogen is being added to it.

THE EFFECT OF LARGE APPLICATIONS OF GROUNO LIMESTONE ON THE YIELD AND NITROGEN CONTENT OF DRY MATTER.

The experiment was conducted in earthenware pots holding approximately 16 to 18 pounds of soil, depending upon the amount of limestone added. To all pots there were added four grams acid phosphate and two grams potassium sulphate, these materials being thoroughly mixed with the soil. Ground limestone was mixed with the soil for certain of the pots as indicated in the table under "Special Treatment." The pots were seeded to barley early in December, 1913, and the crop grown to maturity. Throughout the growing period the moisture content of the soil was maintained at as nearly the optimum condition as possible. At maturity the crop was harvested, dried, weighed and samples prepared for nitrogen determinations.

The special treatment given and the results secured are shown in Table VII.

Table VII—The Influence of Ground Limestone on the Yield and Nitrogen Content of Barley.

Pot No.	SPECIAL TREATMENT.	DRY MATTER GRAMS. Per pot	DRY MATTER GRAMS. Average	Per cent. Nitrog	NITROGEN MGS. Per pot	NITROGEN MGS. Average	Increase over check mgs.
1	No limestone	9 7	9.85	0.984	95.45	95.43	
2		10.0		0.954	95 40		
3	2 gms. $NaNO_3$	21 0	20 90	1.564	328 44	324 80	229.37
4	(No limestone)	20 8		1 544	321 15		
5	10 gms. ground.	12 7	12.35	0 964	122 43	120.26	24.83
6	Limestone (.12%).	12.0		0 984	118 08		
7	81.7 grams ground.	22.0	22.90	1 111	244 42	240.36	144.95
8	Limestone (1%).	23 8		0 993	236.33		
9	163.4 grams ground.	20.0	20.75	1.161	232.20	233 49	138.06
10	Limestone (2%).	21 5		1 092	234.78		
11	408 6 grams ground.	21.2	21.85	1 082	229.38	223 14	127 71
12	Limestone (5%).	22.5		0.964	216.90		
13	817 2 grams ground.	23.9	22 70	0.984	235.18	209.61	114.18
14	Limestone (10%).	21 5		0 856	184.04		

Yield of Dry Matter.

The highest average yield of dry matter was obtained with one per cent. of limestone in the soil, though a yield practically as high was obtained with ten per cent. of limestone. In pots 5 and 6 with .12 per cent. of limestone the yield is only a little higher than with no limestone. With two grams of nitrate of soda the yield is nearly as great as with one per cent. of limestone.

Percentage of Nitrogen.

The highest average percentage of nitrogen, 1.55, occurs with the nitrate of soda. In all cases except one—pots 13 and 14—the average percentage where lime was used is higher than where no lime was used. Excepting the nitrate of soda pots, the highest percentage of nitrogen occurs with two per cent. of limestone. The greatest increase in yield over the check is shown with nitrate of soda. The next greatest increase is with pots 7 and 8 where one per cent. of limestone was used. With heavier applications of limestone the increase over the check becomes gradually less though an unusually low percentage of nitrogen in pot 14 is partly responsible for this. The increase with .12 per cent. of limestone is slight.

Conclusion.

Applications of limestone ranging from one per cent. to ten per cent. gave yields of dry matter which are more than double the yield without limestone and slightly in excess of the yield with nitrate of soda. In other words the soil gave a better response with heavy applications of limestone than with a fair application of nitrate of soda. With applications of limestone the percentage of nitrogen in the dry matter was not so high as with nitrate of soda, but somewhat higher, on the average, than withont limestone. It is quite clear that the presence, in the soil, of an abundant supply of limestone has enabled the plants to ntilize to better advantage the nitrogen of soil organic matter. It is likewise clear that the long continued use of limestone in this way, without the addition of new supplies of organic matter in some form, would ultimately result in the depletion and

exhaustion of the nitrogen supply of the soil. On the other hand the liberal use of stable manure or preferably the frequent growing of leguminous crops for forage or as green manure would largely supply the nitrogen, while the limestone would, as is plainly demonstrated in this experiment, aid in making it available as a plant food. The influence of lime in making available the organic matter of the soil is clearly brought out in the accompanying photograph.

FACTORS INFLUENCING THE PROTEIN CONTENT OF SOYBEANS

During the summer of 1914 a number of pot experiments were conducted to determine the influence of different factors, as for example, fertilizer treatment, thickness of planting, time of harvesting, etc., on the protein content of soy beans. The crops were grown in pots holding about 20 pounds of soil or sand, and lime and minerals (phosphoric acid and potash) were added to all pots except certain ones where these materials were being tested.

Thickness of Planting. This experiment was carried out in soil, and also in sand. In each case all pots received 4 grams acid phosphate, 2 grams potassium sulphate and 10 grams finely ground limestone. For the sand there was also added to each pot 0.5 gram magnesium sulphate and 0.25 gram ferric sulphate. All pots were inoculated with an infusion made from soil taken from a field where soy beans had previously been grown. Moisture was maintained at about 15 to 16 per cent. for the soil and about 10 per cent. for the sand. The crops were grown until the pods were fully formed, but were harvested as forage before the beans had ripened. The results from the soil and sand are shown in Table I.

Table I—Influence of Thickness of Planting on Protein Content of Soy Beans.

No.	Plants per pot.	Grown in soil. Dry matter gms. Per pot.	Grown in soil. Dry matter gms. Average.	Grown in soil. Per cent. nitrogen.	Grown in soil. Nitrogen gms. Per pot.	Grown in soil. Nitrogen gms. Average.	Grown in sand. Dry matter gms. Per pot.	Grown in sand. Dry matter gms. Average.	Grown in sand. Per cent nitrogen.	Grown in sand. Nitrogen gms. Per Pot.	Grown in sand. Nitrogen gms. Average.
1		39.4		3.477	1 370		4.5		3.321	149	
2	2	41 7	43.83	3 450	1 439	1.503	6 0	4.83	2 804	.168	.143
3		50 4		3.372	1.699		4 0		2.777	.111	
4		48.4		3.468	1.679		9 0		3 023	.272	
5	5	50 0	49.53	3.485	1.743	1 753	10 5	9.17	3.345	.351	.293
6		50.2		3.661	1 838		8.0		3 188	.255	
7		54.0		3 415	1.844		15.5		3 599	.558	
8	8	52 2	54.13	3.310	1.728	1.804	13.5	12.17	3 389	.458	.407
9		56.2		3.275	1.841		7.5		2.715	.204	
10		60.4		3.284	1.984		20.0		3.433	.687	
11	12	55.0	58.80	3.317	1.824	1.978	24.5	22.17	3.363	.824	.761
12		61 0		3.485	2.126		22.0		3.503	.771	
13		63 5		3.380	2.146		30 5		3.363	1.026	
14	20	68.0	68.50	3.275	2.227	2 300	33.5	33.67	3.450	1.156	1.117
15		74 0		3.415	2.527		37.0		3.161	1.170	

The rate of seeding varied from two plants per pot to twenty per pot. They were originally planted at the rate of 5, 8, 12, 16, and 25 per pot, but were later thinned to the numbers shown in the table.

In both cases the yield of dry matter increased with the increase in planting, and the increase is much more rapid with sand than with soil. The average yield for the three pots with two plants in soil is 43.85 grams and for twenty plants is 65.8 grams. The average yield for the three pots with two plants in sand is 4.83 grams and for twenty plants it is 33.67 grams

With soil the percentage of nitrogen in all cases is above three per cent. —the average being close to three and a half—with a slight tendency to a higher percentage with the thinner plantings. With sand the plantings from eight to twenty give slightly higher percentages than those from two to five. Here the lowest yield and lowest average percentage of nitrogen is with two plants per pot.

In our earlier work we have noted quite frequently when growing barley in pots, that the dry matter from pots in which only a few plants grew contained a higher percentage of nitrogen than the dry matter from pots in which the full number of plants grew. That is, there seemed to be a tendency for the few plants to take up the nitrogen which the larger number of plants would have gotten had they been present. This does not seem to be so true of the leguminous plants and may mean that in association of numbers there is increased or intensified utilization of atmospheric nitrogen. If this be true the importance of thick seeding in the case of leguminous crops is at once apparent. It is certainly clear that for a given area there is much more nitrogen recovered in the crop with thick than with thin seeding. Thus with soil the amount with twenty seeds to the pot is about one and one-half times the amount with two seeds per pot, and with sand the amount with twenty seeds is about eight times the amount with two seeds. The necessity for thick seeding in sandy soils seems to be especially emphasized.

Date of Harvesting. In this experiment soil only was used, and the fertilizer and lime treatment were the same as with the soil in the previous experiments. All pots were inoculated with an infusion made from the soil taken from a field where soy beans had grown. A sufficient number of pots were prepared to allow cuttings 6, 8, 10, 12, 15 and 18 weeks from date of planting. In harvesting, the stalks were cut as for forage; the soil was then removed from the pots, thoroughly washed away from the roots which were then dried and weighed separately. The variety used was the Guelph. The seeds were planted the 28th of May and the first three pots harvested July 9. The dry weight of the crop, percentage of nitrogen and other data are shown in Table II.

Table II—Protein Content of Soy Beans as affected by Date of Harvesting.

No.	TIME OF HARVESTING	DRY WEIGHT GRAMS. Tops Per pot.	DRY WEIGHT GRAMS. Tops Av'ge	DRY WEIGHT GRAMS. Roots Per pot.	DRY WEIGHT GRAMS. Roots Av'ge	% NITROGEN. Tops	% NITROGEN. Roots.	TOTAL NITROGEN GRAMS. Per pot.	TOTAL NITROGEN GRAMS. Av'ge
1		13 4		2.8		2 620	2 445	419	
2	76 weeks after planting	12 2	12.13	2 8	2.67	2.567	2.313	.378	380
3	(July 9)	10 8		2 4		2.655	2.366	.344	
4		21.5		5.9		2.951	2 839	.802	
5	8 weeks after planting.	22 5	20.53	5 3	5.40	3.181	2.970	.873	.770
6	(July 23)	17 6		5 0		2 892	2.515	.635	
7		41 7		8 3		3.452	3.190	1.704	
8	10 weeks after planting.	39 0	38.30	7 7	7.40	3.356	3.197	1.555	1.54
9	(Aug. 6)	34.2		6.2		3.470	3.119	1.380	
10		31 5		*7 4		2.550	2.918	1 019	
11	12 weeks after planting.	21.7	27 77	6.7	6.93	2.628	2.690	0.751	*0.918
12	(Aug. 20)	30.1		6 7		2.638	2.830	0.984	...
13		59 0		4.0		3.487	1 816	2.130	
14	15 weeks after planting.	63.0	61.93	7 4	5 47	3.610	2.103	2.430	2 231
15	(Sept. 10)	63.8		5.0		3.172	2.191	2.134	
16		58.0		5.0		3 026	1 884	1.849	
17	18 weeks after planting	67 7	55.93	7.0	5 33	3.410	1.953	2.446	1.873
18	(Oct. 1)	42.1		4.0		2.982	1.727	1.324	

*Injured by rats—roots were not injured.

Referring to the dry weight of the tops, it will be noted that with but one exception (where plants were injured) there is a gradual increase from the end of the 6th week to the end of the 15th week, with a slight decrease from the 15th to the 18th, the maximum average weight being 61.93 grams. The maximum average weight for the roots occurs at the end of the 10th week, with a gradual decrease from that time to the end of the 18th week.

The percentage of nitrogen in the tops reaches the average of 3.43 at the end of the 10th week and 3.42 at the end of the 15th week. The low percentage from those harvested August 20 must be attributed to the fact that while these were drying a part of the beans were eaten by rats, thus lowering the percentage of nitrogen and also affecting the weight of dry matter. With this exception the lowest average, 2.61, occurs at the end of the 6th week. A slight decrease in the percentage of nitrogen from the 15th to the 18th week may be attributed to the loss of leaves.

The percentage of nitrogen in the roots reaches a maximum at the end of ten weeks with an average of 3.17. From this date there is a gradual decrease to the end of the 18th week, when the average is 1.85. This decrease is undoubtedly due to the gradual decay and disintegration of the nodules and smaller roots, which could not be saved as the plants became older. This does not necessarily mean that nitrogen has been lost, but that it remains in the soil rather than in the roots, which were taken out of the soil.

From these results it is quite evident that if the beans are to be harvested at forage, harvesting from the end of the 10th to the 15th week will result in giving the maximum protein content. Earlier than the 10th week they have not sufficiently matured to give the maximum percentage of nitrogen, and after the 15th week the loss of the leaves may result in a lower percentage since the leaves are richer in nitrogen than the stems.

Different Fertilizer Materials. In this experiment loam soil was used as in the two previous experiments, and all pots received 4 gms. potassium sulphate, and all were inoculated as in the previous experiments. Three pots were prepared without fertilizer, as a check, and the others received different fertilizing materials as indicated in the table which follows. On May 7th twelve Guelph soy beans were planted in each pot and later they were thinned to ten plants.

On August 14 it was noted that all plants had a good green color, and that all pods were filled, and growth had about ceased. The plants in the check pots were about 16 inches high, and all others about 19 inches high. On the 26th of August the crop was harvested, the plants dried and ground for analysis. The dry matter, percentage of nitrogen, and data with reference to the fertilizer treatment are shown in Table III.

Table III—Protein Content of Soy Beans as Affected by Different Fertilizers.

No.	SPECIAL TREATMENT.	Dry Matter Gms Per pot	Dry Matter Gms Average	Per cent. Nitrogen	Nitrogen Per pot	Nitrogen Average
1	Check	56.7		3.258	1.847	
2		45.5	52.07	3.302	1.502	1.684
3		54.0		3.153	1.703	
4	2 gms. $NaNO_3$ (15.93% N)	49 0		3.398	1.665	
5		53.9	50 07	3.188	1.718	1.630
6		47.3		3 188	1.508	
7	4 gms. $NaNO_3$ (15.93% N)	54.2		3.310	1.793	
8		54 5	54.23	3.179	1.733	1.796
9		54.0		3.450	1.863	
10	10 gms. $CaCO_3$	52.0		3.345	1 739	
11		55 0	51.67	3.337	1.835	1.729
12		48.0		3.363	1.614	
13	25 gms. $CaCO_3$	48.7		3.354	1.633	
14		49.7	50.33	3.275	1.628	1.667
15		52.6		3 310	1.741	
16	4 gms. Acid Phosphate	49.5		3.083	1 526	
17		38.2	46.47	3.302	1.261	1.519
18		51.7		3.424	1.770	
19	8 gms. Acid Phosphate	52.7		3 389	1.786	
20		51.2	50.47	3.170	1.623	1.655
21		47.5		3.275	1.556	
22	2 gms. $CaSO_4$	47 5		3.310	1.572	
23		50.0	50.17	3.232	1.616	1.617
24		53.0		3.135	1.662	
25	4 gms. $CaSO_4$	54.0		3.170	1.712	
26		54.5	55.70	3.187	1.737	1.740
27		58.6		3.021	1.770	

*From this table it will be noted that the yield of dry matter is quite con*stant. The maximum yield of 55.7 gms. occurs with 4 gms. calcium sulphate; while with 4 gms. nitrate of soda the yield is almost as high. The average yield from the check pots is 52.07 gms. which is slightly higher than on some of the pots that received fertilizer.

The percentage of nitrogen is also fairly constant, and it is interesting to note that in no case does it fall below three per cent. The maximum from a single pot is 3.45 where 4 gms. nitrate of soda was applied; the maximum average, 3.348, occurs where 10 gms. calcium carbonate was used, and the average with 25 gms. is only slightly less. The lowest average, 3.126, is found with 4 gms. calcium sulphate. These pots, however, gave the highest yield of dry matter thus placing the yield of total nitrogen in second place, the highest yield occurring with 4 gms. nitrate of soda. It *is of especial interest to note that the limestone gives higher percentages of* nitrogen, on an average, than the nitrate of soda, thus emphasizing the value of an abundant supply of limestone in the accumulation of atmospheric nitrogen, and also making it clear that it is not necessary to add nitrogenous fertilizers in the growing of soy beans, provided the soil is well supplied with lime.

VARIETIES. For this work pots holding twenty pounds of loam soil were used. All pots received 4 gms. acid phosphate, 2 gms. potassium sulphate, *and 10 gms. ground limestone. All were inoculated as in the other ex*periments. Eleven different varieties were planted as indicated in the table which follows. These were harvested as forage but all were not harvested at the same time, as some matured earlier than others. An effort was made to harvest all at about the same stage of maturity, that is after pods had fully formed but before leaves began to fall or beans to shatter out. The weights of dry matter, percentage of nitrogen, and total nitrogen are shown in Table IV.

Table IV—Protein Content of Different Varieties of Soy Beans.

No.	VARIETY.	DRY MATTER GMS. Per pot	DRY MATTER GMS. Average	Per cent. Nitrogen	Nitrogen Per pot, Grams	Average Grams
1		70 0		2.505	1 754	
2	Claud	58 0	64 67	2.811	1 630	1 677
3		66.0		2.496	1.647	
4		37.5		3.608	1.353	
5	Ebony	47.5	41.83	3 380	1.606	1.445
6		40.5		3.398	1.376	
7		55 0		3.196	1.758	
8	Edna	54.0	53 67	3.144	1.698	1.720
9		52.0		3.275	1.703	
10		59.2		3 415	2.022	
11	Guelph	57.0	57.13	3.205	1.827	1.892
12		55.2		3.310	1.827	
13		78.4		3.126	2.451	
14	Hollybrook	74.5	78.60	3.118	2.323	2.455
15		82 9		3.126	2.591	
16		39.0		3.153	1.230	
17	Manhattan	43 0	38.83	3.161	1.359	1.242
18		34.5		3.293	1.136	
19		54.5		3.328	1.814	
20	Medium Yellow	43 2	49 57	3.267	1.411	1 639
21		51.0		3.319	1.693	
22		75.8		2.872	2.177	
23	Ohio 9035	82.0	77.27	2.802	2.298	2.168
24		74.0		2.741	2.028	
25		95.0		2.802	2.662	
26	Swan	93.8	92.77	2.583	2.423	2.560
27		89.5		2.899	2.595	
28		61.7		2.400	1.481	
29	Wilson	62.2	63.13	2.592	1.612	1 586
30		65.5		2.540	1.664	
31		130.5		2.415	3.152	
32	Tar Heel	109.6	121.53	2.511	2.752	3.010
33		124.5		2.511	3.126	

The average weight of dry matter for the different varieties varies from 38.83 gms. with Manhattan to 121.53 gms. with Tarheel. The weights taken from the three pots with any one variety agree fairly well in most cases, showing a fair uniformity of growth.

There is a rather wide variation in the percentage of nitrogen in the different varieties. The Medium Yellow, Ebony, and Guelph show above 3.25 per cent. of nitrogen; the Edna and Manhattan show an average of more than 3 per cent. The Ohio 9035 and Swan show an average of more than 2.75 per cent.; the Claude and Wilson, more than 2.50 per cent.; and the Tarheel shows a average of more than 2.25 per cent. It should be observed than in most cases the percentage of nitrogen in a particular variety runs quite constant. It is of interest to note that the Tarheel, which gives the highest yield of dry matter, shows the lowest percentage of nitrogen. Since this variety does not mature well in this latitude it would not be well adapted for growth if seed were desired. If, however, it were to be used as a forage or green manure crop, its rank growth would probably result in adding to the soil more nitrogen than would be added by some of the smaller varieties. Certainly this was true in this case, for there was recovered in the crop 3.01 grams as against 2.56 grams for the Swan, which was the next highest. The Guelph, with a recovery of 2.45 grams, stands third. The Ebony and Manhattan both produced small plants, and have this much against them if one is considering the enrichment of the soil. The Tarheel, Swan, Hollybrook, and Ohio 9035 all show a recovery of nitrogen in the crop of above two grams.

Experiments With Fertilizers on Cranberries.

JOHN H. VOORHEES.

The study of the fertilization of cranberries started a year ago has been continued this year. It will be remembered that a complete outline of this experimental work is given in last year's report. The first application of fertilizer was made during 1913, and two years' results are now available. These experiments are all located upon bogs owned privately and the work is done co-operatively. Under such a system it is not always possible to control all factors which may in one way or another influence the yield of berries which is of primary interest to the growers. During 1913 series A, B and C, located on a Savanna bottom, deep mud bottom, and deep mud underlaid with iron deposits respectively were comparatively free from limiting factors other than plant food. Series D and E, however, were injured during the season by frost, weeds, insects and scald. This year, 1914, it has been impossible to make plant-food the only limiting factor on any of the series, and the yields were so influenced by outside factors, and in some cases so small, that they are of little value from a practical point of view. Many lessons have been gained, however, by observation of the growth of vine on the various plots treated differently and some interesting data has been collected regarding not only growth and development of vine, but also the effect of fertilizers upon such important controlling factors as insect pests, frosts, weeds, irrigation, drainage, etc.

Series A, located on a Savanna bottom on the lower and upper Meade bogs owned by Joseph J. White, at Whitebogs, N. J., was seriously attacked by the fire worm and bloom worm during the summer months, and yet, the yields were large enough to show clearly the advantage of fertilization by increasing both the size and yield of berries. It was impossible to measure in any way the injury caused by these pests, but the writer found the insects scattered generally over the entire series of plots. That the injury was large was evident from the number of insects present. Preventative measures were used by spraying with arsenical poisons but this was not done until much injury had been accomplished. Arsenical poisons seemed very effective in controlling the bloom worm, but the fire worm was not so easily combated. This invasion of insects was probably much greater than it would have been had there been sufficient water for reflowing at the time of their first appearance.

The following table gives the results of picking and records the size tests for 1913 and 1914. In explanation of these results which are recorded in pounds, it has been found that one pound of berries will approximate very closely one quart. The size tests were made by counting the number of berries, as they came from the picker, necessary to fill the small cup furnished to members of the Growers Cranberry Company by the American Cranberry Exchange. Three cups of berries from each plot were counted, and the average of the three counts computed to give the average size of berries. All berries are included in the picking regardless of size, insect or other injury, in order to get the weight of the entire crop. Series "A" has shown little scald or insect injury to the berries.

Series "A" Savanna Bottom—J. J. White's Bog.
Size of Plots: One-Twentieth Acre.

No. of Plot.	Application or Treatment.	1913 Cost of Fertilizer in Cents.	1913 Yield per Plot in Pounds.	1913 Average Size of Berries.	1914 Cost of Fertilizer in Cents.	1914 Yield per Plot in Pounds.	1914 Average Size of Berries.
1	14 lbs. Nitrate of Soda.	38	230.75	105	35	73.00	111
2	Nothing.		186.75	126		79.25	112
3	10 lbs. Ammonium Sulphate.	37	190.00	116	36	71.50	116
4	Nothing	.	176 00	118	.	94.50	120
5	20 lbs. Dried Blood.	45	183 25	112	47	85.50	109
6	Nothing	.	209 00	118	.	73 75	118
7	30 lbs. Cotton Seed Meal.	55	211.00	120	52	77 00	110
8	Nothing.	..	191.00	112	..	82 00	113
9	14 lbs. Nitrate of Soda. 25 lbs. Acid-Phosphate. 10 lbs. Muriate of Potash.	73	250 75		71	94.75	94
10	Nothing	..	163 50	128	.	60.25	119
11	10 lbs. Ammonium Sulphate. 25 lbs. Acid Phosphate. 10 lbs. Muriate of Potash	72	159.50	97	72	53 50	104
12	Nothing.	.	144.25	..	..	41 00	117
13	20 lbs. Dried Blood. 25 lbs. Acid Phosphate. 10 lbs. Muriate of Potash	80	299 25	116	83	56 75	103
14	Nothing.		180 25	121	...	66 00	124
15	30 lbs. Cotton Seed Meal. 25 lbs. Acid Phosphate. 10 lbs. Muriate of Potash.	90	236 75	95	88	77.50	106
16	Nothing	.	154.00	115	.	43.25	117
17	25 lbs Acid Phosphate.	15	134.00	118	15	67 25	115
18	Nothing.		111.75	127	..	45.00	114
19	25 lbs. Basic Slag.	18	121 00	112	19	52.50	121
20	Nothing.	.	99.75	116	.	46 00	112
21	15 lbs. Phosphate Rock.	09	95.50	112	09	67.25	105
22	Nothing.	..	101.75	112	.	54.75	116
23	15 lbs. Steamed Bone.	23	137.50	108	23	81.75	113
24	Nothing.	..	132.25	118	..	82.50	112
25	30 lbs. Bone Meal 2–30. 10 lbs. Ammonium Sulphate. 10 lbs. Muriate of Potash.	93	92.75	116	94	119.25	104
26	Nothing.	..	90.25	139	..	108.50	113
27	25 lbs. Basis Slag. 10 lbs. Nitrate of Soda. 10 lbs. Muriate of Potash	77	272.25	112	75	174.25	92
28	Nothing.	..	241.75	111	..	82.50	114
29	15 lbs Phosphate Rock. 10 lbs. Ammonium Sulphate. 10 lbs. Muriate of Potash.	66	263.00	117	66	154.75	102
30	Nothing.	..	226.25	120	..	120.75	115
31	15 lbs. Steamed Bone. 10 lbs. Ammonium Sulphate. 10 lbs. Murate of Potash.	80	213.25	112	80	108.75	92
32	Nothing.	..	194.75	115	..	90.00	119
33	10 lbs. Muriate of Potash.	20	267.25	100	21	75.50	101
34	Nothing.	.	258.75	113	..	102.25	114
35	10 lbs. Sulphate of Potash.	22	169.00	107	24	152.50	120
36	Nothing.	..	132.25	123	..	114.00	119
37	42 lbs. Kainit.	23	158.50	113	24	135.50	111
38	Nothing.	..	122.25	123	..	117.75	114
39	10 lbs. Sulphate of Potash. 10 lbs. Ammonium Sulphate. 25 lbs. Acid Phosphate.	75	179.25	107	76	149.25	106
40	Nothing.	..	137.00	117	..	178.50	109
41	42 lbs. Kainit. 10 lbs. Ammonium Sulphate. 25 lbs. Acid Phosphate.	76	144.25	111	75	154.00	104
42	Nothing.	....	102.00	122	..	133.75	118

By compiling thefigures given in the table above it may be noted that the use of fertilizer supplying all three elements of plant food on plots 9, 11, 13, 15, 25, 27, 29, 31, 39 and 41 caused an average increase in yield of 29% in 1913 and 23% in 1914, while at the same time there was an average increase in size of ten per cent. in 1913, and fifteen per cent. in 1914. It should be remembered in this connection that the fertilizer was not applied until June 1913, whereas the fruit buds had been formed the previous year for the 1913 crop, so that the increase in yield must have been caused first by an increase in size, and second, by a strengthening of the vines, which undoubtedly enabled them to bring more berries to maturity. During 1914 there may have been more fruit buds formed, but if this is true, the writer has been unable to observe it or to make any definite record to that effect.

On plots 1, 3, 5 and 7, which received only nitrogen, there was an average increase in yield over the check-plots of six per cent. in 1913, and an average decrease of seven per cent. in 1914, while at the same time the increase in size was five and three per cent. respectively. The growth of vine on these plots was enormous considering the fact that only nitrogen was applied, and runners were very numerous. This shows clearly that nitrogen at the rate of forty pounds per acre applied alone is excessive, and tends to cause runners to grow at the expense of fruit bud formation and fruit development.

Plots 17, 19, 21 and 23, which received phosphoric acid in different forms, showed an increase of nine per cent. in average yield in 1913, and eighteen per cent. in 1914. The size of the berries increased five per cent. in 1913, but showed no increase in 1914, probably due to the larger number. Plots 33, 35 and 37 receiving potash only, showed an average increase in yield in 1913 of fifteen per cent., and eight per cent. in 1914, while in the same years the size increased twelve and five per cent. respectively.

Regarding the source and form of the various materials used for supplying plant-food, observations of growth indicate that nitrate of soda, acid phosphate, and muriate of potash, have produced more nearly the growth desired than any other materials, though judgment should be used in determining the amount of nitrogen supplied. Upon soils other than the light sandy Savanna bottom, forty pounds of nitrogen per acre in either nitrate of soda or ammonium sulphate caused an excessive growth of vine, especially runners. In another series located at Jamesburg the yields almost decreased to nothing. Appearances of growth show that phosphate rock produced nearly as good growth as either acid phosphate or basic slag, and further experimentation may prove it to be of value on bog soils which are acid in nature, because it is much less costly. Plot 21 upon which it was used showed very clearly that it takes very nearly a year to become available in any sufficient amount to cause an increase in yield or size. During the second year, however, it caused an increase in yield over its check No. 22 of twenty-four per cent., and an increase in size of ten per cent.

INDIRECT AFFECT OF FERTILIZATION.

While this test and others similar to it were planned to study primarily the effect of the fertilization of cranberries, there are a number of incidental observations the writer has made which bear directly upon the industry. As early as September a year ago the vitality of weeds, mostly sedges, seemed to be weakened. Four plots on John W. Vohman's bog at Jamesburg which are fertilized with complete mixtures have grown excessively, too much in fact, but this excessive growth has crowded the weeds almost entirely out. Red root, a weed which is very serious in many bogs of the State, has suffered severely and it is hoped that fertilization will prove to be a capable means of destroying this weed. The effect of fertilizat ion upon it was first noticed in plots on the Pole Bridge bog owned by Joseph J. White. During June and July 1914, the year old stalks of this weed could be located and distinguished almost anywhere in the series of plots. Wherever the growth of vine had been stimulated by fertilization there were few new plants coming up. On the contrary, where no fertilizer had been applied, the growth of the new plants appeared normal.

It is also the writer's belief that fertilization will strengthen the vines so materially that they will be better able to withstand frost and insect injury. It was observed this year that fertilized vines recovered very quickly from slight frost injury. Where the injury was very severe new uprights were produced to take the place of the frozen ones. On the other hand, the increase of organic matter which accumulates on fertilized plots forms very favorable conditions for the protection and development of the girdle worm which is already spreading in many plots. It is believed that sanding will prove an efficient remedy for this trouble, and

a prevention against spread of the insect. The advisability of this method is doubtful, however, because it is generally believed that sanding makes conditions favorable for the development and spread of diseases. There is no definite information on this point. Cape Cod growers are today experiencing much trouble with cranberry diseases, believed by many to be brought about by increased sanding.

The Acidity of Cranberry Bogs.

Cranberries thrive on a wide variation of soil. It is generally believed that this plant requires an acid soil, and yet, there are several growers using lime on cranberry bogs, and claim good results. Preliminary tests show that the lime requirement of cranberry soils in New Jersey varies from approximately 1,000 lbs. calcium oxide in white sand soils, to 8,000 to 10,000 lbs. calcium oxide in muck soils. Preliminary tests have been conducted this year to study the adaptation of cranberries to soils having varying amounts of acidity. The writer believes that this may furnish some valuable information regarding the adaptation of different varieties to cranberry soils as they exist. It is hoped to learn the degree of acidity in which cranberries thrive best. The test referred to also includes the use of finely powdered copper sulphate and manganese sulphate. The former, used extensively in spray mixtures, is believed to act as a stimulant and at the same time cause root injury. The latter element, manganese, supplied in the form of sulphate, is believed to be used in a small degree by the plant as a food. This experiment is only preliminary in nature and very small plots, one-hundredth of an acre, have been used. The plan follows:

No. of Plot.	Treatment.	No. of Plot.	Treatment.
1	Check	16	Check.
2	.125 lbs. Copper Sulphate	17	2 lbs. Sulphur.
3	Check	18	4 lbs. Sulphur.
4	.25 lbs. Copper Sulphate	19	5 lbs. Ground Limestone.
5	Check	20	10 lbs. Ground Limestone.
6	.500 lbs. Copper Sulphate	21	Check.
7	.5 lbs. Manganese Sulphate	22	Check.
8	1.0 lbs. Manganese Sulphate	23	20 lbs. Ground Limestone.
9	Check	24	40 lbs. Ground Limestone.
10	Check	25	2.5 lbs. Ground Burned Lime.
11	2 lbs. Manganese Sulphate	26	5.0 lbs. Ground Burned Lime.
12	4 lbs. Manganese Sulphate	27	Check.
13	.5 lbs. Sulphur	28	Check.
14	1.0 lbs. Sulphur	29	10 lbs. Ground Burned Lime.
15	Check	30	20 lbs. Ground Burned Lime.

This work is being conducted on the two most common types of soil. Applications were first made last spring and to date there appears no change in growth.

Experiments With Fertilizers on Newly Set Bogs.

In the spring of 1913, Mr. A. D. Clarkson, of Pennington, N. J., wrote the Experiment Station regarding co-operative experimental work and offered the use of his cranberry bogs located about one and one-half miles from New Gretna in Burlington County for experimental purposes. Upon inspection the bogs were found to be in poor condition and it was not considered wise to run any extensive experiments. One newly set bog, however, had been carefully turfed and set the previous spring. The condition of this bog warranted experimental work and ten one-twentieth acre plots (33 x 66) were laid out and fertilized the twelfth of June, 1913, as follows:

No. 1—25 lbs. acid phosphate, 10 lbs. muriate of potash; No. 2—check, no fertilizer; No. 3—25 lbs. acid phosphate, 10 lbs. muriate of potash; No. 4—25 lbs. acid phosphate, 10 lbs. ammonium sulphate; No. 5—25 lbs. acid phosphate, 10 lbs. ammonium sulphate; No. 6—check, no fertilizer; No. 7—10 lbs. muriate of potash, 10 lbs. ammonium sulphate; No. 8—10 lbs. muriate of potash, 10 lbs. ammonium phosphate; No. 9—25 lbs. acid phosphate, 10 lbs. ammonium sulphate, 10 lbs. muriate of potash; No. 10—25 lbs. acid phosphate, 10 lbs. ammonium sulphate, 10 lbs. muriate of potash.

It is rather difficult to give a clear and well defined description of this bog. It consisted approximately of three acres without any systematic method of flowing. The natural drainage water of the surrounding country was depended upon for winter flooding. It received

no artificial irrigation. The soil consisted of a layer of fine muck varying from three to six inches deep underlaid by sand varying greatly in thickness, which in turn was underlaid by a fine white gravel. The muck was well decomposed having little if any fibrous material or roots in it which may help to account for a greater amount of soil moisture than is commonly found in similar bogs in the same locality.

In the fall of 1913 plots 1 and 3, 7 and 8, and 9 and 10 had made good growth. The runners were long, numerous and many had already taken root. Plots 4 and 5 had not made such good growth and an occasional vine appeared weakened. The check plots had grown normally but showed less vigor than expected and noted especially in plots 1 and 3. The gates were closed about the middle of November and the bog was entirely flowed on December first.

The water was drawn from the bogs during the last week in May, 1914. At this time the vines appeared healthy. Observations made on June 19th showed occasional dead vines throughout the fertilized plots. Upon examination some vines were found to have been killed by the tramping of deer. No other evidence of injury could be located. The application of fertilizer were again made on the same plots. Subsequent observations showed a healthy condition, good growth and the proper number and distribution of fruit buds. This growth continued, according to Mr. U. J. Allen, Manager, until shortly after a heavy rain which occurred during the latter part of the second week in August. Mr. Allen's observations a week after the rain showed the vines beginning to turn brown. The runners and new growth were first affected.

Personal observation made September 16th showed that the vines on plots 7-10 inclusive had died. The greater number of vines in plots 1 and 3 and 4 and 5, were also dead but a few still remained alive. These were weak and had lost most of their leaves. Even in the case of those plots resetting will be necessary. So far as observations go, no injury of any description other than the fertilizer injury, contributed to this condition. There was no evidence of toad-bugs, girdle-worms, root-worms, or fire-worm injury.

It is believed by the writer that this fertilizer injury was caused by a lack of proper drainage and irrigation. This bog was dependent entirely upon the surrounding country for its irrigation, which this year was very limited, on account of the dry season. The fertilizer applied in June undoubtedly remained in the soil or on the top of it until the slight rain referred to when it was dissolved and carried into the soil water. This, however, made a solution too concentrated so that the plants were unable to get the food contained in it. Had there been sufficient rain during the season to properly irrigate this bog, or if the bog had been equipped with an adequate reservoir for irrigation, it is believed by the writer that the loss of vine would not have occurred.

Report of the Biologist.

OBSERVATIONS RELATIVE TO OYSTER PROPAGATION AT BARNEGAT AND TUCKERTON, 1914.

§1. INTRODUCTION AND SUMMARY.

Departmental Relations.

Our studies of oyster propagation for the season of 1914 were confined to the stations at Barnegat and Tuckerton. Owing to a twenty-five per cent. cut in our appropriation, we were obliged to abandon the Scullville Station. But while there was a decreased amount available for this purpose by the Experiment Station, the total appropriation for "the scientific study of oysters," was greater than ever before granted by our State. The State Bureau of Shell Fisheries after three years of waiting, received an appropriation of $500 for the maintenance of "observation stations" for securing the sort of data detailed in our present report. As the Bureau of Shell Fisheries had co-operated with the Experiment Station in maintaining the Scullville Station for the season of 1913, this Bureau would have carried on the Scullville Station on its own responsibility in 1914 if the appropriation had been placed in the Supplemental Act. Unfortunately it was not available until November, too late for use in the present season.

The plans for this observation service were worked out as a result of our researches in those biological sub-stations of the State Agricultural Experiment Stations, known technically as the "Oyster Culture Laboratory." This service was undertaken by the Bureau of Shell Fisheries because of its desire to co-operate with and to supplement this particular line of work of the Experiment Station. In a similar manner the National Bureau of Fisheries conducts scientific investigations in the field of Aquatic Animal Industry, thus supplementing the work of the Bureau of Animal Industry which is a branch of the Federal Department of Agriculture. In turn this latter department has included in its operations, a supervision of the Oyster Industry in connection with questions of pollution, floating, etc. Logically these relations must become closer and more extended, for no fundamental line can properly be drawn between departments of research having the common object of the production of human food, whether derived from the vegetable or the animal kingdom, or from vertebrates or invertebrates, especially when such production involves cultural methods. The word "Agriculture" properly covers the entire set of industries herein involved. Therefore, when the Bureau of Shell Fisheries prosecutes experimental

work in Oyster Culture it allies itself closely with the Agricultural Experiment Station.

The records of the observation service will be of great value to our work. We wish to undertake investigations of many other lines of work without abandoning the collecting of those data which would be of a character similar to the records of an observation service.

Our oyster experimental work is expanding, new vistas for research are opening and it is to be deplored that any tendency exists towards restricting financial provision for a branch of Agriculture which needs perhaps even more than its proportion of attention. The oyster industry is worth more than five millions of dollars annually to the people of New Jersey.

Stations and Assistants.

The Barnegat Oyster Station building was erected in 1905 upon land belonging to Captain Joseph K. Ridgway, who has generously given free the use of the site for all these years. This year, however, there was opportunity to dispose of this land by sale. Logically we should have purchased the site because it would cost more to secure another site and to move the laboratory than to pay the hundred dollars asked for the plot 100 by 100 feet, upon which the laboratory stands. There seemed to be obstacles in the way of present purchase by the Station, hence a lease of the land for ten years was executed, with option of purchase in the *interin*. In this way this laboratory was secured for the immediate future for continued work along the lines of the scientific investigation of oyster propagation." This Station is on the whole most admirably situated, and has many advantages above those offered at any other place in the oyster areas of our State. We have heretofore placed an assistant in charge of this Station, chosen from the undergraduate body, from those best qualified, who would accept the required conditions of the work. During the season just ended, we had the good fortune of securing the services at only a slight advance in cost, of John N. Lowe, Ph. D., instructor in the University of Wisconsin.

The Tuckerton Station was again located at Edge Cove where our floating laboratory, the house boat "Cynthia" was anchored at practically the same spot as during the previous season. This also is a most admirable location, natural spatting beds and planted oysters being near at hand. The site is, however, a little too exposed and it is our intention to move up Ezra Creek to a more sheltered location. This will put us a quarter of a mile farther from the places where observations must be made. So to facilitate travel, we secured a portable gasoline motor for the row boat, necessarily used in these waters which are exceedingly shallow at low tide, not permitting the use of the launch. With our various boats and instruments, this comfortable laboratory is now well equipped for work. It is the summer headquarters of the biologist, who must, however, be free to leave whenever his diversified duties make it desirable. As it is necessary that some one be continuously

present to supervise the different automatic recording instruments, and to make the regular records, an assistant is imperative, and frequently the presence of two persons is needed. Mr. T. C. Nelson, B. S., also an instructor in the University of Wisconsin, has been for years the chief assistant upon whom reliance has been placed in the running of this Station. His qualifications and experience make his services valuable.

Owing to the fact that Mr. Nelson was detailed by the National Bureau of Fisheries to investigate oysters in Mobile Bay, his services were available for only one month. It became necessary to make special arrangements. We secured as a "learner-assistant," without salary, Mr. F. F. Bacon, son of the chief of the Bureau of Shell Fisheries, who helped out for three weeks. Later in the season, during the period when the chief could best be spared, the biologist responded to a call from the Biological Board of Canada, to investigate the Oyster Industry in Prince Edward Island. During this period the laboratory was in charge of P. C. Cameron, a graduate of merit from the Wagner Institute of Science, Philadelphia. The Canadian oyster industry has suffered the usual experience of every oyster region, viz., it is threatened with destruction if it continues simply as a "fishery" and does not apply cultural methods. The biologist gave addresses to the oyster fishermen and others interested, at ten different points in the province of Prince Edward Island. Incidental to this labor, a better grasp of the subject was secured which must ultimately help our home work.

Summary for the Season.

As the excellent oyster exhibit prepared for the Columbian Exposition in 1893 was destroyed by fire in 1903, we have begun the work of establishing an oyster museum for the exhibition of the features of oyster biology as they become unfolded by our studies. This should prove instructive, not only to the lay and professional public, but particularly to those who are engaged in oyster research or expect to undertake such work. A room in the basement of Jersey Hall has been fitted with cases to contain the new collection, of which a nucleus is already in hand.

The season now closing has emphasized the influence of weather conditions upon oyster propagation. At the opening of the season, oysters were in a condition of unusual fecundity, and there was promise of an unusually large production of young seed oysters. But the climatic conditions obtaining in July repressed the emission of spawn to the detriment of the quality of the eggs, and also destroyed the possibility of the occurrence of well defined climaxes of "spatting." Thus we were unable to predict any date when shells should have been planted. There was a dribbling out of a few eggs at a time, and a more or less continuous "setting" of a few spat, with slight increases on such dates as June 29th, July 18th and 27th, August 3rd and 18th and 24th corresponding to periods of increased temperature. Of these dates, those at July 27th and August 3rd were the principal climaxes—some localities like Barnegat receiving their principal set of spat earlier and others like Tuckerton late in July or early in August.

The proportion of eggs that hatched was small compared with the original supply of spawn, and only a limited proportion of the swimming larvæ lived to the spat stage; the few that did "set" were too weak to survive in the usual ratio. In good years, there is a big loss of spat during winter, due to frosts and storms. But the unusual death rate of the spat for this year is attributed by the writer to inherit weakness of the eggs caused by their long retention in the ovary, due to cold spells. At least it is not evident that there were any external influences of an extra injurious character. We shall now consider in detail the weather factors in their order.

§2—CLIMATIC CONDITIONS.

Explanatory of Tables I and Ia.

In Tables I and Ia are shown the records of climatic conditions at Barnegat and Tuckerton respectively. Usually two daily observations were made, one in the morning before seven o'clock and one in the afternoon at three o'clock. In the column headed "Sky R" are entered the cloudiness and precipitation. Absence of record indicates a clear sky. In the next column under "Tem. Bar." stand the number of degrees Fahrenheit of the air, registered by the thermometer. Also the reading of the Aneroid barometer is given in the Edge Cove table. Next follows the column for the direction and force of the wind. Where a number is entered it represents the feet per minute of the wind velocity as determined by an anemometer. Otherwise the following abbreviations are used: "mod," moderate; "str," strong; "lt," light breezes. In the column under "tide ht," we give the state of the tide at the hour of observation, whether "l" low, or "h" high, ebb or "flo"; a number indicates the reading of the tide gage. At Barnegat this is indicated in inches, o being average low water. At Tuckerton the automatic gage recorded "points," twenty of which are the equivalent of a foot, (a ratio determined by adjustment for this Station). The next column gives the height and hour of high water. Where two numbers are given the higher indicates the "spring" tide, the lower the "neap" tide. The next column gives the density and tempearture of the water. The next two columns give similar data for low water, while the "miscellaneous" column supplements all the preceding columns with explanatory remarks or supplementary data.

Weather Summary.

From the U. S. Department of Agriculture "Climatological Data" of New Jersey, we learn from the monthly "General Summary" that June averaged 0.8 degrees cooler than usual, though the temperature rose into the nineties on some few days while other days were so cool as to permit frost. There was a decided deficiency in rain, added to a lack of ground water from an unusually dry winter. The cold periods fell on the 6th and from the 15th to the 22nd. The warm periods came in the first week and from the 24th to the 27th. The precipitation averaged 1.17 inches below normal.

July averaged 2.3 degrees below normal, with deficiency of rain, for the first half of the month, but with frequent showers during the second half. There was excessive cloudiness, especially on the coast. The last four days were the coldest ever recorded on similar dates; and cold periods also fell on the 1st, 3rd to 8th and 20th. On the other hand warm days came on the 12th, 16th to 18th, 23rd and 26th. (Note the *frequent alternations of hot and cold waves.*)

August averaged about a degree above normal, with warm waves on the 7th to 12th, 15th to 24th and the last three days. Rainfall was 1.87 inches below normal, with more clear days than usual, broken by severe thunder storms. September was noted for absence of rain. (As the weather this month does not affect the problem of oyster propagation of the season of 1914, we need not consider this matter further.)

Water Conditions and Precipitation.

During the past season, the temperature of the water was subject to great fluctuations; in fact it varied more than the salinity, due to the *frequent cold waves and continued drought.* At Barnegat the water reached 80 degrees on June 25th, but had fallen to 67 on July 4th. It rose to 85 on July 18th, but was down to 70 by July 30th. On August 8th it reached 86 degrees, but was 72 on the 26th, and fell to 64 degrees by September 10th. Of course these variations were parallel with the air temperature, and are to be explained by the shallowness of the water areas in which our studies were conducted.

At Edge Cove, 85 degrees was registered on June 25th, 70 July 6th, 80 July 12th and 19th to 27th, 70 on the 30th, 82 on August 12th to the 23rd and 64 on September 10th. The average temperature at Barnegat was 74.5 degrees both at low and at high water, ranging from 65 degrees to 86, and fluctuating five or six degrees and sometimes twice this extent, *within a single day. At Tuckerton the temperature at low* tide was 75, the same as at Barnegat, but on high water averaged three degrees warmer. High water should average colder than low water, but it is possible that the incoming tide was warmed up coming over extensive sand flats, and that colder currents veered in at outgoing tides. Possibly also we may explain this by the fact that the deeper Bay water was not cooled off so fast as the shallow shore waters, by the numerous cold spells of the season.

In spite of the general drought conditions, rains were recorded on 24 days from mid June to mid September, with a total precipitation at Edge Cove of 10.74 inches. The majority of the showers yielded less than a quarter of an inch each, and only four produced more than an inch. The thirsty ground drank up this water, so that little of it reached the sea to temper the salinity which was unusually high and steady.

At Barnegat the mean salinity was 1015.5, ranging from 1006 to 1020. At Tuckerton the mean was 1019.3 with a range from 1009 to

1021, somewhat salter than at Barnegat. This is to be explained by the fact that the Barnegat Station is situated on a river, while the Tuckerton Station is in a cove.

In respect to the tides, "O" represents average low water, the extreme range at Barnegat was 17 inches, at Edge Cove 4 feet. We experienced no "storm tides."

Table I—Climatic Data Pertaining to Oyster Propagation, Barnegat, 1914.

Date.	Hour.	Sky R.	Temp.	Wind F.	Tide Ht.	High Hr.	Den. Tem.	Low Hr.	Den. Tem.	Miscellaneous.
June 10.	4:00 p.m.		74	S. str.	L. ebb	Noon.		Eve.		
June 11.	12:30 p. m.		86	N. W. lt.	High.			Morn		
June 11.	3 p. m.		89		Ebb.					
June 11.	9 p. m.		78	Calm	Flow.					
June 12	6 a. m.	Cloudy.				12:30 p. m. 6.5.		8 p. m. 3.0.		
June 12.	9 a. m.	Hazy.	77	S. E. mod.	Flow 4.5.					
June 12.	12:30 p. m.		80	S. W. mod.	High 6.5.					
June 12.	3 p. m.		82	S. W.	Ebb, 5.5.					
June 13.	*Midnight.*		68	*Calm.*	High.	*1.00 p. m.*		8 a. m.		
June 14.	7 a. m.	Hazy.	66	Calm.	Low.	2 p. m. 8.0.	20–68	9 a. m. 2.5.		Dens. at A.
June 14.	3 p. m.	Cloudy.	70	N. E. lt.	Ebb, 7.0					
June 14.	7 p. m.	Rain.	66	S. E. lt.	Ebb, 3.5.					
June 15.	7 a m	Rain.	62	N. E. mod.	Ebb, 6.0.	3 p. m.	18–72	10 a. m.		Station A
June 15.	*4 p. m.*	*Hazy.*	69	N. E. lt.	Ebb, 7.5.					
June 16.	7 a. m.		61	N. W. str.	Ebb, 6.5	4 p. m.	15–72	11 a. m. 4.5.	16–68	
June 16.	4 p. m.		75	N. W. str.	High.					
June 17.	6:20 a. m.		60	N. W. lt.	High, 6.0	6:30 p. m. 11.5	15–69	Noon 0.0.	12–74	
June 17.	9 a. m.		70	N. W. lt.	Ebb, 1.5.					
June 17.	Noon.		69	S. E. str.	Low, 0.0					
June 17	6:30 p. m.	Cloudy.	70	S. str.	High, 11.5					
June 18.	6 a. m.	Hazy.	58	Calm.	Ebb, 1.5.	7 p. m	16–74	Noon 0.0.	15–69	Dens at high ebb, A.
June 18.	9:45 a. m.	Hazy.	69	S. E. mod.	Low, 0.0	6 a. m.		Noon		
June 18.	6:30 p. m.	Cloudy.	70	S. E. mod.	Flow, 3.0					
June 19.	6 a. m.	Rain.	68	S. E. mod.	Flow, 4.5	7 a. m. 5.5		1 p. m. 0.5	14–74	16–74, A. 10 a. m.
June 19.	2:45 p. m	Cloudy.	73	E. mod.	Flow, 1.7					
June 20.	6:20 a. m.		57	N. W. str.	Flow.	7:45 a. m.		1.30 p. m. 0.0	11–72	15–74, A. 4 30 p. m.
June 20.	2:10 p. m.		71	N. mod.	Low, 0.0.					
June 20.	7 p. m.		68	S. W. lt.	Ebb, 4.0.					
June 21.	7 a. m.	Cloudy.	61	S. W. mod.	Flow, 3.5.	8:30 a. m. 5.0		2 p. m. 0.5	10–70	
June 21.	Noon.	Cloudy.	69	S. str.	Ebb, 0.5.					
June 22.	6:30 a. m.	Rain.	68	N. var.	Flow, 3.3	9:30 a. m. 5.5	16–70	2 30 p. m. 0.0	10–73	Hard rain at night
June 22.	2 p. m.	Cloudy.	73	S. E. lt.	Ebb, 0.0.					16–68, A, 7 a. m.
June 23.	6:15 a. m.	Cloudy.	69	E. var.	Flow, 4.5.	10:30 a. m. 5.0	16–72	3 p. m. 1.0	09–78	
June 23.	2:30 p. m.	Cloudy.	74	S. E. mod.	Ebb, 1.5.					
June 24	6:30 a. m.	*Fog.*	71	*S. E. calm.*	*Flow, 5.0.*	*11 a. m. 7.5*	15–78	4 p. m. 1.7	06–78	
June 25	2:30 p. m	Cloudy.	78	S. E. str.	Ebb, 3.5.					
June 25.	6:20 a. m		72	W. mod.	Flow, 4.7	11:30 a. m. 8.1	16–78	5 p. m. 3.0	10–84	
June 25.	2:45 p. m.		91	W. str.	Ebb, 4.0.					
June 26.	6:30 a. m.	Cloudy.	75	N. E. str.	Flow 6.0.	Noon 7.0.	17–80	6 p. m. 1.5	08 82	
June 26.	*2:30 p. m.*		79	S. E. mod	Ebb 4.0.					
June 27.	6:30 a. m.	Hazy.	68	N. E. lt.	Flow 5.1.	1 p. m. 6.5	16–82	6:30 p. m. 2.0	16–77	Dens. at A, 8.30 a. m.
June 27.	2:30 p. m.	Rain.	76	S. E. str.	Ebb.					7 hours hard rain

Table I—Climatic Data Pertaining to Oyster Propagation, Barnegat, 1914. (Continued)

Date.	Hour.	Sky R.	Temp.	Wind F.	Tide Ht.	High Hr.	Den. Tem.	Low Hr.	Den. Tem.	Miscellaneous.
June 28.	6:20 a. m.	Fog.	72	N. E. mod.	Flow 9.5.	2 p. m. 12.5	16 76	7 p m. 9 0		Gale, 7:30–9:30 p. m. followed by rain.
June 28.	1:45 p. m.	Fog.	79	N. E. mod.	Flow 12.0.					
June 29.	6 a. m	Cloudy.	68	S. W. str.	Ebb 10 1.	3 p. m. 12.0.		8 p. m.		7:30 a. m , A, 15–75.
June 29.	2:10 p. m.	Hazy.	82	S. W. strgr.	Flow 12.1.					6 p. m., A, 16–78.
June 30.	6:30 a. m.		62	N. W. str.	Ebb 8.7.	4 p. m. 12.5	16–75, A	9 p. m. 7.5.		7:45 a. m. A, 17–68.
June 30.	2:45 p. m.	Cloudy.	76	N. W str.	Flow 11.5.					
July 1.	6:35 a. m.	Hazy.	62	S. calm.	Ebb 6.3	5 p. m. 10.0.	15–71 at	9 p. m. 3 0.	09–75	8 a. m. S. str. Rain all night. Shwrs
July 1.	2:10 p. m.	Rain.	73	S str.	Flow 5.0.		8 a m A	3.0, ebb at.	08 76	
July 1.	6 p. m.	Rain.	70	S. W. lt.	Ebb 9.0.		16 70, A	11:30 a. m.		E. at 6 30; storm all night.
July 2.	6:40 a. m.	Cloudy.	71	N. W. mod.	Ebb 9.0.	6 p. m. 13.0	17–1m	10 a. m. 6.0		8 a. m. A, 17–72.
July 2.	2:30 p. m.	Cloudy.	82	W. lt.	Flow 9 0.					Rain 5 to 6 p. m.
July 3.	6:45 a. m.	Mist.	65	N. E. str.	Ebb 11.0	7:10 p. m. 15.0.	17 70	Noon 7.0.		
July 3.	2.30 p. m.	Cloudy.	71	N. E. mod.	Flow 9.0					
July 4.	6:30 a. m.	Cloudy.	59	S. E. lt.	High 9.0.	6.45 a. m. 10 0		1 p. m. 4.0.		7:30 a. m. A, 17–66.
July 4.	2:50 p. m.		71	S. E. lt.	Flow 5.5.					
July 5.	6:35 a. m.	Rain.	64	S. lt.	Flow 10.0.	7:50 a. m. 11.0		2 p. m. 6.5.		Lt rain, continuing all night.
July 5.	1:45 p. m.	Cloudy	70	S. E. lt.	Ebb 7.0.					
July 6.	6:40 a. m.	Cloudy.	66	N. E. str.	*Flow 6.1.*	8:30 a. *m. 9.0*		3 p. m. 6.0.		7.30 a. m. A, 17–68.
July 6.	2 p. m.	Rain.	72	N. E str.	Ebb 7.0.					Laght rain.
July 7.	6:30 a. m.	Rain.	60	W. mod.	Flow 11.0.	9:10 a. m. 13.0.	16–65	4 p m 6 0.		Wind variable.
July 7.	2:10 p. m.	Cloudy	72	S. W. str.	Ebb 8.0.					Showers, clearing 5 p. m.
July 8.	6 a. m.		67	S. E. lt	Flow 7.5	10:30 a. m. 10.0		5 p. m. 4.0.		7 a. m A, 14–71.
July 8.	2:45 p. m.	Cloudy.	75	S. E. mod.	Ebb 6 0.					
July 9.	6:30 a. m.	Fog.	70	S. E. lt.	Flow 6.5.	11 a. m 10.0		5.30 p. m. 4.5.		*Heavy rain 9:30 to 10:15 a. m*
July 9.	2:35 p. m.	Fog.	78	N. E. lt.	Ebb 7.5.					6:30 a. m A. 15–72.
July 10.	6 a. m.	Fog.	70	E. lt	Flow 6 5.	Noon 10 0.		6 p. m. 5.0		Fog lifted 11 a m.
July 10.	2:10 p. m.	Cloudy.	75	E. mod.	Ebb 7.0.					6:40 a. m. A. 14–72.
July 11.	6:45 a. m.	Fog.	70	N. E. lt.	Flow 7.0.	12 30 p. m.		6 a. m. 5 5		7:50 A. 16–72
July 11.	2:15 p. m.		76	N. E. mod.	*Ebb 7.0.*					
July 12.	6 a. m.	Fog.	72	E. lt.	Ebb 9.0.	1 p. m. 11.0.		7 a. m. 6.0		Storm 1:30 to 2:10 p m 86 deg.
July 12.	2:26 p. m.	Cloudy.	79	S E. mod.	Ebb 10.0.					
July 13.	6:30 a. m.	Cloudy.	73	N. E mod.	Ebb 8.0.	2:40 p. m. 11.7		8 a. m. 6.0	11 71	At A.
July 13.	2:10 p. m.	Cloudy.	80	N. E. lt.	Flow 11.5.					7 p. m A, 11–78
July 14.	6 a. m.	Fog.	74	S. E. str.	Ebb 8.2.	3 p. m. 12 0	15–76, A	9 a. m. 6 0.		6:20 a. m, A, 15–76
July 14.	2:45 p. m.	Rain.	74	S. E. str.	Flow 11.1.					
July 15.	6 a. m.	Clearing.	70	S. E. calm.	Ebb 8.7.	3.40 p. m. 12.0		10 a m 5 0		6:45 a. m. A, 09–74.
July 15.	2 p. m.	Fog.	76	S. E. str.	Flow 10.5.					1:15 p. m. A, 14–78.
July 16.	6 a. m.		76	S. lt.	Ebb 6.0.	4:20 p. m. 7.0.		11 a. m. 1.2.		6:45 a. m. A, 13–79
July 16.	4 p. m.		82	S. str.	Flow 5.0.					
July 17.	6:40 a. m.		77	S. mod.	Ebb 6 5.	5 p. m. 6.0.		12 20 p m. 1.5		7:30 a. m str. S
July 17.	2 p. m.	Hazy.	84.5	S. str	Flow 3.2.					7:45 p. m A, 14–80.
July 18.	5 a m		77	S lt	Ebb 7 0.					

Table I—Climatic Data Pertaining to Oyster Propagation, Barnegat, 1914. (Continued)

Date.	Hour.	Sky R.	Temp.	Wind F.	Tide Ht.	High Hr.	Den. Tem.	Low Hr	Den. Tem.	Miscellaneous.
July 18	10:50 a. m.	Cloudy	88	N. W. lt.	Ebb 4.2.					
July 18	11:42 a. m.		88	N. E. lt.	Ebb 4.2.	6 a. m. 7.0	14-80, A	1 p. m. 3.2.		3 p. m. A, 13-86.
July 18	2:22 p. m.		84	E. str.	Flow 4.7.					
July 19	6:30 a. m.		70	N. mod.	Ebb 6.5.	6.30 a. m. 7.0		1:40 p. m. 1.5		
July 19	2:45 p. m.		81	N. W. mod.	Flow 2.5.					
July 20	6 a. m.		59	N. W. lt.	Flow 4.0.	7 a. m. 5.5	15-70, A	2:35 p. m. 0.0	08-81	
July 20	2:35 p. m.		74	S. str.	Low 0.0					
July 21	6:20 a. m.	Hazy.	79	S. W. str.	Flow 2.7.	8 a. m. 4.0.	15-71, A	1.45 p. m. 0.5.		10 a. m. gale all day.
July 21	2 p. m.	Hazy.	82	S. W. gale	Low 0.5					
July 22	6:40 a. m.		70	N. str.	Flow 1.7.	9 a. m. 10.0.		1 p. m. 0.5.	11-79	8 a. m. A, 17-73.
July 22	2:45 p. m.		77	N. E. str.	Ebb 0.5.					
July 23	6 a. m.		68	S. lt.	Flow 1.5.	9:30 a. m.		3 p. m. 1.0.		9:10 a. m. S. str.
July 23	1:15 p. m.		85	S. str.	Ebb 0.0.					7 p. m. rain
July 24	6:10 a. m.	Fog.	72	N. E. str.	Flow 5.0.	10 a. m. 10.0		3:15 p. m. 1.0.		7.10 a. m. A, 18-72
July 24	2:40 p. m.		80	N. str.	Ebb 1.0					
July 25	6:15 a. m.	Rain	68	S. lt.	Flow 4.0	11:45 a. m. 11.0	17-76	4:30 p. m. 5.0.		
July 25	2:35 p. m.	Cloudy.	76	S. mod.	Ebb 7.0					
July 26	6 a. m.	Cloudy.	72	W. lt.	Flow 0.5.	12:40 p. m. 12.5		5:30 p. m. 7.0		
July 26	2:50 p. m.	Cloudy.	86	W. str.	Ebb 0.9.					
July 27	6:10 a. m.		76	N. E. lt.	Flow 7.0.	1.40 p. m. 11.0		7 p. m. 7.0.		7.30 a. m. A, 15-78.
July 27	2:40 p. m.		81	N. E. mod.	High 11.0					7:30 p. m. light showers
July 28	6 a. m.	Cloudy	69	N. E. lt.	Ebb 0.6	2:30 p. m. 16.0		8 p. m. 11.0.		*Rain all last night.*
July 28	2:30 p. m.	Rain.	76	N. W. mod.	Flow 15.0.					3.25 p. m. clearing.
July 29	6:30 a. m.		60	N. W. str.	Ebb 11.0.	4 p. m. 17.0	17-68, A	9 a. m. 11.0	16-66, A	N. W. str. all night
July 29	1:30 p. m.		72	N. W. str.	Flow 15.5					6.30 a. m. lab. 15-67
July 30	6 a. m.	Cloudy	59	N. E. str.	Ebb 13.0.	1.45 p. m. 24.0		10:30 a. m. 12.0		1 a. m. terrific N. E. storm.
July 30	Noon.	Rain.	69	N. E. gale.	Flow 16.0					Showers all day.
July 30	2:35 p. m.	Rain.	74	N. E. str.	Flow 20.5					N. E. storm.
July 31	6 a. m.	Fog	61	N. str.	Ebb 15.0.	5:40 p. m. 16.0		11 a. m. 12.0		6:45 a. m. rain.
July 31	2:15 p. m.	Cloudy.	73	N. E. mod.	Flow 15.0.					7 a. m. lab. 13-62
Aug. 1	6:45 a. m.		63	S. W. str.	Ebb 10.0	6:45 p. m. 10.0		Noon 2.0		9.30 a. m. lab. 10-73
Aug. 1	2 p. m.		80	S. str.	Flow 3.0.					9.30 a. m. Br. 06-73.
Aug. 2	6 a. m.		71	S. str.	Flow 9.0.	8 p. m. 10.0.		1.10 p. m. 1.0		
Aug. 2	2:10 p. m.	Hazy.	79	S. str.	Flow 1.0.					
Aug. 3	6:35 a. m.		69	S. lt.	*Flow 11.0.*	*9 p. m. 13.0.*		*1.30 p. m. 1.0*		*Hard storm last night*
Aug. 3	2:30 p. m.	Cloudy.	79	S. lt.	Flow 5.0.					11.30 a. m. lab. 11-77
Aug. 4	6:40 a. m.	Cloudy.	70	N. E. str.	Flow 12.0	9 a. m. 11.0		2 p. m. 5.5		
Aug. 4	2:26 p. m.	Fog	73	N. E. mod.	Flow 6.0.					
Aug. 5	6 a. m.	Fog.	68	N. E. str.	Flow 13.5.	9:45 a. m. 16.0		2:30 p. m. 5.0		
Aug. 5	2:20 p. m.	Cloudy.	78	N. E. str.	Ebb 5.0.					
Aug. 6	6 a. m.	Fog	70	N. E. str.	Flow 11.0.	10 p. m. 15.0.		3 p. m. 5.0.		6:30 a. m. A, 14-74
Aug. 6	1:30 p. m.	Cloudy.	78	N. E. mod.	Ebb 6.5.					

Table I—Climatic Data Pertaining to Oyster Propagation, Barnegat, 1914. (Continued)

Date.	Hour.	Sky R.	Temp.	Wind F.	Tide Ht.	High Hr.	Den. Tem.	Low Hr.	Den. Tem.	Miscellaneous.
Aug. 7	4 a. m.		70	S. lt.	Flow 7.0	10:30 a. m. 13.0		4 p. m. 1.0		1:20 p. m. A, 13–81.
Aug. 7	2:55 p. m.		81	S. str.	Ebb 1.0					
Aug. 8	6 a. m.		76	S. lt.	Flow 5.0	11 a. m. 10.0		5 p. m. 0.0		6 a. m A, 14–76
Aug. 8	2:10 p. m.		83	S. str.	Ebb 5.0					
Aug. 9	6 a. m.		78	S. lt.	Flow 2.0	Noon 7.0		6 p. m. 0.0		
Aug. 9	Noon		86	S. str.	Flow 6.0					
Aug. 10	5:45 a. m.		79	S. lt.	Ebb 2.5	1 p. m. 6.0		6:35 p. m. 1.0		6:35 p. m. cloud, 79, gale S.
Aug. 10	2:45 p. m.		82	S. str.	Ebb 2.0					9 p. m. light rain.
Aug. 11	5:40 a. m.	Cloudy.	74	S. lt.	Ebb 2.0	2 p. m. 6.0		7 a. m 2.0	14–76, A	6:45 a. m. S str
Aug. 11	1:45 p. m.	Cloudy.	83	S. str.	Flow 5.5					8 to 10 p. m. big thunder storm.
Aug. 12	6 a. m.	Cloudy.	76	S. str.	Ebb 1.5	2:30 p. m. 7.0		7:30 a. m 1.0		
Aug. 12	2:10 p. m.	Cloudy.	80	S. str.	Flow 6.5					
Aug. 13	6 a. m.	Cloudy.	68	N. W. mod.	Ebb 3.5	3 p. m. 6.5		8 a. m. 1.5	13–69, A	
Aug. 13	2:45 p. m.		79	E. str.	Flow 6.0					
Aug. 14	6:38 a. m.		64	S. calm.	Ebb 3.1	4 p. m. 8.0		9 a. m. 2.0	10–72, A	9 p. m. S strong
Aug. 14	2:10 p. m.		78	S. str.	Flow 6.0					
Aug. 15	6:10 a. m.	Fog.	74	S. lt.	Ebb 5.5	5 p. m. 10.0	14–78, A	10 a. m 3.0		10–11 a m. N.—N. E
Aug. 15	2:30 p. m.	Cloudy.	84	N. E. mod.	Flow 6.0					
Aug. 16	6:42 a. m.		68	S. E. mod.	Ebb 5.0	6 p. m. 7.5		11 a. m. 2.5		
Aug. 16	2:30 p. m.		79	S. E. str.	Flow 3.5					
Aug. 17	5:30 a. m.		70	S. lt.	Flow 4.0	7 p. m. 6.0	12–71, A	Noon 0.0		3 p. m. big gale.
Aug. 17	2:45 p. m.	Cloudy.	78	S. E. str.	Flow 0.5					
Aug. 18	6 a. m.		69	S. lt.	Flow 3.0	8 a. m. 5.0		1:30 p. m 1.0		*Foggy forenoon*
Aug. 18	2:45 p. m.		85	S. str.	Flow 1.0					4:25 p. m. A, 11–81.
Aug. 19	5:45 a. m.	Fog.	76	S. mod.	Flow 4.7	9 a. m. 8.0		2:45 p. m. 0.5		7 a. m. A, 13–80.
Aug. 19	2:20 p. m.		88	S. str.	Low 0.5					
Aug. 20	6:45 a. m.		78	S. lt.	Flow 6.0	10 a. m. 8.0	14–86, A	3:30 p. m. 1.0		
Aug. 20	2:30 p. m.		87	S. E. str.	Ebb 1.2					
Aug. 21	6:45 a. m.		78	S. str.	Flow 6.7	10:30 a. m. 10.5		4:30 p. m. 0.5		S. strong all last night
Aug. 21	2:30 p. m.		85	S. str.	Ebb 2.1					5 p. m. gale; 6 p. m rain.
Aug. 22	5:38 a. m.		70	W. lt.	Flow 7.0	11:30 a. m. 13.0		5:30 p. m. 8.0		7:10 a. m. A, 15 74.
Aug. 22	2:10 p. m.		80	N. E. str.	Ebb 11.5					
Aug. 23	6:50 a. m.		70	S. lt.	Flow 6.7	Noon 11.0		6:30 p. m. 1.0		8 a. m. A, 14–77.
Aug. 23	2:15 p. m.		80	S. str.	Ebb 4.2					High wind all p. m.
Aug. 24	6:15 a. m.	Fog.	74	S. str.	Ebb 7.0	1:30 p. m. 12.0		7 a. m 6.5	9 a. m.	S. strong all night.
Aug. 24	2:15 p. m.		88	S. str.	Ebb 11.0				15–82, A	3 p. m. 92, F.
Aug. 25	6:45 a. m.	Cloudy.	68	N. E. str.	Ebb 8.0	2 p. m. 14.2	18–72, A	7:40 a m. 7.0		
Aug. 25	2:40 p. m.	Cloudy.	73	N. E. str.	Ebb 13.7					p. m. little rain
Aug. 26	6 a. m.	Cloudy.	65	N. E. str.	Ebb 7.0	3 p. m. 11.7	16–72, A	8:30 a. m. 5.0		Rain all last night.
Aug. 26	2:30 p. m.	Cloudy.	74	E. str	Flow 11.5					
Aug. 27	6 a. m.	Cloudy.	68	N. E. str.	Ebb 6.7	4 p. m. 12.0		9:30 a. m. 4.0		1 p. m. A, 15–75.
Aug. 27	2:20 p. m.	Cloudy.	76	E. str.	Flow 11.1					

Table I—Climatic Data Pertaining to Oyster Propagation, Barnegat, 1914. (Continued)

Date.	Hour.	Sky R.	Tem.	Wind F.	Tide Ht.	High Hr.	Den. Tem.	Low Hr.	Den. Tem.	Miscellaneous.
Aug. 28.	6:40 a. m.*	Cloudy.	70	E. lt.	Ebb 6.0.	5 p. m. 12.5.	Noon.	10 a. m. 3.0.		5:30 p. m. showers.
Aug. 28.	2 p. m.	Cloudy.	77	E. lt.	Flow 10.0.		17–76, A			9 p. m. showers, N. E. storm.
Aug. 29.	7 a. m.	Cloudy.	74	W. lt.	Ebb 6.5.	6 p. m. 15.0.	14–80, A	10 a. m. 4.0.		11:25 a. m. strong wind began.
Aug. 29.	2:25 p. m.	Cloudy.	80	S. E. gale.	Flow 8.0.					
Aug. 29.	7:15 p. m.	Cloudy.	80	S. E. lt.	Flow 10.0.					
Aug. 30.	6:30 a. m.		72	N. W. mod.	Ebb 10.5.	5 a. m. 13.0.		11 a. m. 8.0.		
Aug. 31.	6:45 a. m.		69	W. mod.	Ebb 9.0.	6 a. m. 10.0.		Noon 6.0.	13–79, A	N. E. str. last night, little rain.
Aug. 31.	2:30 p. m.	Cloudy.	84	W. mod.	Ebb 5.0.					
Sept. 1.	6:40 a. m.		70	S. lt.	Flow 9.0.	7 a. m. 9.5.		1 p. m. 1.5.		E. str. last night.
Sept. 1.	2:10 p. m.	Cloudy.	82	S. strgr.	Flow 2.0.					
Sept. 2.	6:30 a. m.		76	S. mod.	Flow 8.5.	8 a. m. 10.0.	15–78, A	2 p. m. 2.0.		
Sept. 2.	2:25 p. m.		89	S. strgr.	Flow 5.5.					
Sept. 3.	6 a. m.		78	S. strgr.	Flow 7.0.	9 a. m. 6.0.	14–80, A	3 p. m. 3.0.		
Sept. 3.	2:30 p. m.		89	S. strgr.	Ebb 4.0.					
Sept. 4.	6:30 a. m.		70	S. W. lt.	Flow 7.2.	10 a. m. 10.0		4 p. m. 3.0.		8 p. m. very strong S.
Sept. 5.	6 a. m.		58	N. W. mod.	Flow 6.1.	11 a. m. 10.0	15–74, A	5 p. m. 2.5.		Rained last night.
Sept. 7.	6:20 a. m.	Cloudy.	71	S. lt.	Flow 5.2.	Noon 9.0		6 p. m. 2.0.		8:40 a. m. A, 16–76.
Sept. 7.	2:30 p. m.		85	S.W. strgr	Ebb 6.5.					
Sept. 8.	6 a. m.	Cloudy.	56	N. W. lt.	Flow 3.5.	1 p. m. 11.0		6:30 p. m. 1.5.		4:30 p. m. A, 17–69
Sept. 8.	2:45 p. m.	Cloudy.	72	N. W. str.	Ebb 7.0.					
Sept. 9.	6:45 a. m.		48	N. W. str.	Ebb 1.5.	2 p. m. 7.0.		7:30 p. m. 1.0.		11 a. m. A, 18–66
Sept. 9.	3:25 p. m.		45	N. E. str.	Ebb 4.0.					
Sept. 10.	7 a. m.		48	N. W. mod.	Ebb 1.7.	3:20 p. m. 8.0.	18–68, A	8:30 a. m. 0.5		
Sept. 10.	2:30 p. m.		70	N. E. mod.	Flow 7.5.					
Sept. 11.	6 a. m.		49	N. W. lt.	Ebb 2.0.					

Table Ia—Climatic Data Pertaining to Oyster Propagation, Edge Cove, 1914.

Date.	Hour.	Sky R.	Tem. Bar.	Wind F.	Tide Ht.	High Hr. *Points	Den. Tem.	Low Hr.	Den. Tem	Miscellaneous.
June 24	11:30 p. m.	Rain.		N. W. mod.		10 a. m. 11		3 p. m. 5		
June 25	Morn.	Clearing.		N. W. lt.						
June 25	Noon.		92	S. W. lt.						
June 25	Eve.		88	S. mod.						
June 26	Morn.		72	N. E. mod	Neap. T	Noon 50.	20 80	Eve. 9.		Spring tide, midnight.
June 26	Noon.		77	E. lt.						
June 26	Afternoon.		78	S. E. lt.						
June 26	Eve.		74, 30.00	S. lt.						
June 27	6 a. m.		66	E. calm.	Low.	12:20 a. m. 70		7 a. m. 13.	20 76	3:45 p. m. rain .3 inches
June 27	3 p. m.	Cloudy.	79, 29.88	S. E. 1420	Ebb.	12:45 p. m. 53.		6:30 p. m. 13		Wind circles twice
June 28	7 a. m.	Rain, .55.	72, 28.10	S. E. lt.	Low ebb.	1 a. m. 70		8 a. m. 16		a. m. S. L. str., noon S. W. clearing
June 28	3 p. m.	Hazy.	80, 27.90	S. W. 2150.	High ebb.	2 p. m. 63		8 p. m. 22		11 p. m. S. E., fearful gale.
June 29	5 a. m.		70 27.70	S. W. lt.		2 a. m.		9 a. m.		
June 29	3 p. m.		84	N. W. str.		3 p. m.				
June 30	7 a. m.		60	N. W.	Ebb	3 a. m.		10 a. m.		
June 30	8 p. m.		72	Calm.	Low ebb.	3:45 p. m.				6 p. m. 78. F.
July 1.	7 a. m.		75, 30.15	Calm.	Ebb.	4 a. m.		10:30 a. m.	20 73	7.30 a. m. S.
July 1.	3 p. m.	Rain, .52.	74	S. W. mod.	High flow.	4:20 p. m.				Evening str. S. storm.
July 2.	6 a. m.	Cloudy.	72, 27.50	W. mod.	High ebb.	5 a. m. 58.	20 75	11 a. m. 14.	20-72	Rain measures .52 inches
July 2.	3 p. m.		81, 28.10	W. lt.	High flow.	5 p. m. 65.				
July 2.	6 p. m.	Rain .06.	77, 28.30	N. lt.	High ebb.					
July 3.	7 a. m.	Cloudy.	64, 30.00	N. E. mod.	High ebb.	5 a. m. 46.		Midnight, 17.		
July 3.	3 p. m.	Cloudy.	65, 30.09	N. E. mod.	High flow.	5:30 p. m. 70.		11:30 a. m. 7.		
July 4.	7 a. m.	Clearing.	63, 30.20	N. lt.	Neap.	6 a. m. 44.		12:30 a. m. 10		
July 4.	3 p. m.		70, 30.14	S. mod.	Flow.	7 p. m. 64.		12:30 p. m. 0.		
July 5.	7:30 a. m.	Cloudy.	68, 30.09	S. E. mod.	High ebb.	8 a. m. 50.				
July 5.	3 p. m.		77	S. E. lt.	Low flow.	8:20 p. m. 70.		1:30 p. m. 5.	20 76	6 p. m. threatens.
July 6.	6:30 a. m.	Cloudy.	66, 30.06	N. E. mod.	Flow.	8:20 a. m. 50.		3:30 a. m. 13.	20-70	
July 6.	3 p. m.	Cloudy.	73, 30.00	N. E. 1700.	Low.	9 p. m. 80.		2:45 p. m. 8.		Rain at 8 00 p. m. .25 inches.
July 7.	6:45 a. m.	Cloudy.	60, 29.80	S. W. 1460.	Flow.				20-70	Rainy last night.
July 7.	3 p. m.	Cloudy.	73, 29.90	S. W. mod.	Low.	10 p. m. 60.		3 p. m. 0.		
July 8.	6:45 a. m.		71, 30.12	S. W. mod.	Low flow.	10:30 a. m. 45.		5 a. m. 6.		
July 8.	3 p. m.	Cloudy.	76, 30.10	S. W. mod.	Low ebb.	11 p. m. 65.		5 p. m. 4		6:30 p. m. 72 deg.
July 9.	6:45 a. m.	Fog.	71, 30.10	S. E. calm.	Low flow.	11 a. m. 46.	20-72	6 a. m. 9.		
July 9.	3:30 p. m.	Cloudy.	75, 30.00	S. E. mod.	Ebb.	10:20 p. m. 65.		5 p. m. 5.		
July 10.	6:30 a. m.	Fog.	71, 30.00	E. calm.	Low.	Noon 53.		6 a. m. 11	20-75	
July 10.	3 p. m.	Hazy.	74, 30.00	S. E. mod.	Ebb.	Midnight 64		6:30 p. m. 11.		
July 11.	6:30 a. m.	Rain.	70, 29.90	S. E. mod.	Low.	Midnight 64.	19-78	7 a. m. 11		
July 11.	3 p. m.		76, 29.90	S. E. mod.	High ebb.	1 p. m. 50.		7 p. m. 13		
July 12.	7 a. m.		75, 29.80	S. W. lt.	Low ebb.	1 a. m. 60	21-80	8 a. m. 13	09-79	Thunder storm 2 p. m. 1.53 inches.

*Note—Twenty "points" of tide are the equivalent of one foot

Table Ia—Climatic Data Pertaining to Oyster Propagation, Edge Cove, 1914. (Continued)

Date.	Hour.	Sky R.	Tem. Bar.	Wind F.	Tide Ht	High Hr.	Den. Tem.	Low Hr	Den. Tem.	Miscellaneous
S. . .	3:30 p. m. .	Clearing. . .	78, 29.80	S. E. mod. . .	High ebb.	2 p. m. 56. .		8 p. m. 17. .		
July 13.	7 a. m. . . .	. . . .	74, 29.80	N, calm. . .	Low ebb.	2 a. m. 60. .		8 a. m. 12. .	18-78	
July 13.	3 p. m. . . .	. . . .	79, 29.80	S. E. mod. . .	High ebb	2 p. m. 55		8:30 p. m 18 .		
July 14.	7 a. m. . . .	Cloudy. . .	75, 29.90	S. E. calm. .	Low ebb. . .	2:30 a. m 61. .		9:30 a. m 13		Warm evening, calm.
July 14.	3 p. m. . .	Rain.	73, *29.85*	S. E. *mod.* .	High.	*3 p. m. 55*		*9 p. m. 19*		
July 15.	6 a. m. . . .	. . . .	73, 29.80	S. W. calm. .	Ebb.	3 a. m. 55		10 a. m. 12. .		
July 15.	3 p. m. . .	Cloudy. . .	*80, 29.80*	*E. mod.* . .	*High flow.* .	4 p. m. 58.		*10:30 p. m 20*		
July 16.	6:30 a. m. .	. . . .	76, 29.90	S. W. mod. .	Ebb.	3:30 a. m 49		10:00 a. m. 14		Strong S. W after 7 a. m.
July 16.	3 p. m. . . .	. . . .	81, 29.80	S. W. str. .	High flow. .	5 p. m 60		11 p. m. 20		
July 17.	6:30 a. m. .	. . . .	78, 29.80	S. W. mod. .	Ebb.	4 a. m. 46 .		10:30 a. m. 15		Str. S W. last night, showers
July 17.	3 p. m. . . .	. . . .	82, 29.70	S. W. mod. .	High flow. .	5 p m. 60		11:30 p. m. 18.		
July 18.	6:30 a. m. .	. . . .	78, 29.70	S. W. calm. .	High ebb	5 a. m. 37.	18-84	11 a. m. 11		S. W last night.
July 18.	3 p. m. . . .	. . . .	86, 29.76	E. mod. . . .	Flow.	6 p. m. 60		Midnight 16.		N. W. at 7 a m.
July 19.	7:15 a. m. .	. . . .	74, *28.05*	N. W. *mod.* .	*High ebb*	*5:30 a. m. 40*	19-79	*Midnight 16.* .		
S. . .	3:30 p. m. .	. . . .	70, 28.02	N. W. mod. .	Flow. . . .	6:30 p. m 58.		Noon 11. . .		
July 20.	7:10 a. m. .	. . . .	63, 30.00	N. W. calm. .	High.	7 a. m. 38.	19 74	1:30 a. m. 10		
July 20.	*3 p. m.* . . .	. . . .	78, 29.09	S. W. mod. .	Flow.	7 p. m. 60.		1:30 p m. 8. .		
July 21.	7 a. m. . . .	. . . .	74, 30.00	S. W. str. .	High.	7:30 a m. 30.	19-78	2:30 a. m 5.		Strong wind last night
July 21.	3 p. m. . . .	. . . .	83, 29.90	S. W. str.	Low flow. .	8:30 p. m. 51.		2:30 p. m. 2 .		11:45 a m wind 1600 ft minute
July 22.	7 a. m. . . .	. . . .	74, 30.00	N. E. calm. .	High flow. .	8:30 a m. 33	19 76	3 a. m. 3.	19 78	
July 22.	3 p. m. . . .	. . . .	82, *30.20*	*S. E. mod.* .	*Low.*	*9 p. m. 64*		*2:30 p. m. 2*		
July 23.	7 a. m. . .	. . . .	72, 30.02	S. W. lt. . .	Flow. . .	10 a. m 35.		4:30 a. m 5	19-82	Wind at noon 1978 ft. minute
July 23.	3:30 p. m. .	. . . .	88, 29.90	S. W. str.	Low.	10:30 p. m. 65. .		4 p. m 0		7:15 p. m str N 1., rain 03 inches
July 24.	7:30 *a. m.* .	Cloudy. . .	72, 29.90	N. E. mod. .	Low flow	10:30 a. *m* 51	20-82	5 a. m. 4		
July 24.	3 p. m. . . .	. . . .	83, 29.90	S. E. mod . .	Low Ebb.	11 p. m. 68.		5 p. m. 6		
July 25.	7 a. m. . .	Rain. .	67, 28.08	N. W. calm.	Low flow	11:30 a. m 55	20 77	6 a. m. 11	21-72	Clears 7 a. m., S. W. light.
July 25.	3 p. m. . .	Cloudy. . .	74.	S. W. mod. .	Ebb. .	Midnight 62.		5:30 p. m. 9. .		Thunder storm 6 p. m.
July 26.	7:30 a. m. .	. . . .	*76, 29.90*	*N. W. calm.* .	*Low.*	*Midnight 62.* .	*19 80*	*7 a. m 10*	*19 78*	
S. . .	3 p. m. . . .	. . . .	86, 29.85	S. W. mod. .	Ebb. .	12:30 p. m. 51.		*6:30 p. m. 10* .		
July 27.	7 a. m. . .	. . . .	76, 29.92	Calm. . . .	Low. .	12:30 a. m 61.	20 81	7:30 a. m. 9	20-78	8 a. m. N. E. light.
July 27.	*3 p. m.* . . .	. . . .	81, 29.84	S. E. str. .	High ebb.	1 p. m. 60. .		7 p. m. 12	19-80	6 p. m. rain, W. 9 p. m., S. str
July 28.	8 a. m. . .	Rain 2.20. .	68, 29.93	S. E. lt . .	Low ebb. .	1 a. m. 56.	19-78	8 a. m 12 .	10-70	N. E during last night
July 28.	3 p. m. . .	Cloudy. . .	71, 29.80	N. E. mod	High flow	2 p. m. 61.		8 p. m 18.		N. E str. late afternoon
July 29.	9 a. m. . .	. . . .	68, 29.90	N. E. mod . .	Low ebb. .	. . . . .	20-72	8:45 a. m. 19. .		
July 29.	3 p. m. . . .	. . . .	75, *29.90*	*E. str.*	*High.* . . .	3 p. m. 73.	*19-75*	*9:30 p. m 24.* .		
July 30.	8 a. m. . .	Cloudy. . .	68, 30.00	N. E. str. .	Low ebb	3 a. m. 58. .		9:30 a. m. 18	20-69	Rain last night, 12 inches
July 30.	0 p. m. . .	Clearing. .	69, 30.10	N. E. str.	High ebb	1 p. m. 78	20-70	10 p. m. 32.		Showers during day.
July 31.	7 a. m. . .	Cloudy. . .	63, 30.12	N. E. mod. .	Ebb. .	1 a. m. 60		10:30 a. m 15.		
July 31.	3 p. m. . .	Clearing. .	70, 30.10	N. E. mod . .	High flow. .	5 p. m. 73.		Midnight 19. .		
Aug. 1	7 a. m. . . .	. . . .	66, 30.00	S. W. mod.	High ebb. .	5 a. m. 41		Midnight 19. .	20-70	Wind str. to N.
Aug. 1	3 p. m. . . .	. . . .	76	. . . .	Flow. . .	6 p. m. 64.		11:30 a. m. 5.	. . . . . .	S. W. in evening; threatens
Aug. 2	7 a. m. . . .	. . . .	71, 29.95	S *W. mod.*	High ebb	6 a. m. 38.	*20-72*	*1:30 a. m 8* .		*Blew all night*

Table Ia—Climatic Data Pertaining to Oyster Propagation, Edge Cove, 1914. (Continued)

Date.	Hour.	Sky R.	Temp.	Wind F.	Tide Ht.	High Hr.	Den. Tem.	Low Hr.	Den. Tem.	Miscellaneous.
S.	4:30 p. m.	Hazy	76, 29.85	S. W. str.	Flow	7 p. m. 62.		Noon, 2.		
Aug. 3	7:30 a. m.	Clearing	68, 29.85	S. W. lt.	High	7:30 a. m. 40.	19–74	2:30 a. m. 7		.80 rain at 4 a. m ; thunder.
Aug. 3	6 p. m.	Threatens.	75	E.	Low flow.	7:45 p. m. 65.		1:30 p. m. 5.		S. W. str. 3 p. m.
Aug. 4	7:30 a. m.	Cloudy	73, 29.97	N. E. mod.	High flow.	8 a. m. 46.		3 a. m. 11.		Calm morn. 77 at 3 p. m.
Aug. 4	8:30 p. m.	Cloudy	70, 30.00	N. E. mod.	Low flow	8 p. m. 71.		*2:30 p. m.* 6.		*73 at 3 p. m.*
Aug. 5	7:30 a. m.	Cloudy	69, 30.00	N. E. lt.	High flow.	9 a. m. 55.		4 a. m. 15.		
Aug. 5	3:30 p. m.	Clearing	70, 30.00	E. lt.	Low ebb.	10 p. m. 66.		4 p. m. 9.		
Aug. 6	7:30 a. m.	Hazy	71, 30.10	S. E. mod.		10 a. m. 55.				Tide gage on strike.
Aug. 6	12:30 p. m.		*70, 30.09*	N. W. calm.	*Low ebb.*	*10:30 p. m.* 68.		4:30 p. m. 10.		S. E. light most of day.
Aug. 7	8 a. m.		74, 30.10	N. W. lt.	Flow	10.30 a. m. 50.		5:30 a. m. 14.		
Aug. 7	4 p. m.		80, 30.04	S. W. str.	Low ebb.	11 p. m. 59.		5 p. m. 9.		Str. S. W. during night.
Aug. 8	7 a. m.	Cloudy	73, 30.02	S. W. lt.	Low flow.	11:20 a. m. 45.		6 a. m. 10.		Calm morn.
Aug. 8	4 p. m.		80, 29.96	S. W. mod.	Low ebb.	11:45 p. m. 55.		5 p. m. 6.	18–77	
Aug. 9	8:30 a. m.		82, 30.00	Calm	Low flow.	Noon, 48.		*6:40* a. m. 7.		
S.	3:15 p. m.		88, 29.96	S. W. str.	Ebb.	Midnight 56.		6 p. m. 10.		
Aug. 10	8:30 a. m.		80, 30.00	S. W. mod.	Low flow.	Midnight 56.		7 a. m. 10.		
Aug. 10	3:30 p. m.		82, 29.98	S. W. str.	Ebb.	12:30 p. m. 53.		7 p. m. 10.		Rain in evening; S. W. 2316 ft.
Aug. 11	6 a. m.	Clearing	76, *30.00*	S. W. str.	*Low.*	*12:30 a. m.* 46.		7 a. m. 10.		Rain .04 in. 1880 ft.
Aug. 11	3 p. m.	Hazy	83, 29.02	S. W. str.	High ebb.	1 p. m. 50.	18–82	7 p. m. 12.		Wind 2105 ft.
Aug. 12	9 a. m.	Clearing	68, 29.98	N. W. mod.	Low flow.	1:30 a. m. 40.		7:30 a. m. 11.		.70 inches rain last night.
Aug. 12	3 p. m.	Rain	70, 29.96	S. E. mod.	High ebb.	2 p. m. 55.		8 p. m. 11.		1.00 inch rain in afternoon.
Aug. 13	*7:30 a. m.*		*68, 30.00*	*N. W. lt.*	*Low ebb.*	*2 a. m. 45.*		8:20 a. m. 12.		*Calm night.*
Aug. 13	8 p. m.		74, 30.00	S. W. lt.	Low ebb.	2 p. m. 58.		9 p. m. 20.		Tide gage approximate.
Aug. 14	8 a. m.		74, 29.92	W. calm.	Low ebb.	3 a. m. 45.	18–80	9 a. m. 16.		
Aug. 14	6 p. m.		77, 29.82	S. W. str.	Ebb.	3:30 p. m. 65.		10 p. m. 22.		Windy night.
Aug. 15	7 a. m.	Hazy	74, 29.84	S. W. lt.	Ebb.	3:30 a. m. 44.	18–78	9:30 a. m. 19.		Calm morn, and day.
Aug. 15	1:45 p. m.	Hazy	84, *29.85*	N. W. calm.	*High ebb.*	*4:30 p. m. 61.*		11 p. m. 22.		
Aug. 16	7:30 a. m.		70, 29.98	N. W. lt.	Ebb.	4:30 a. m. 44.		10:30 a. m. 20.		54 deg. at 5:30 a. m.
S.	3 p. m.		76, 30.00	S. E. str.	High flow.	5 p. m. 70.		Midnight 22.		
Aug. 17	7 a. m.		70, 30.00	S. lt.	High ebb.	5 a. m. 47.		11 a. m. 17.		West thunder storm 1.30 p. m.
Aug. 17	*3 p. m.*	*Clearing.*	80, 29.98	S. str.	Flow.	5:30 p. m. 66		Midnight 20.		Lasting 1.5 hour rain .44 inches.
Aug. 18	7 a. m.	Fog	68, 29.99	S. E. lt.	High.	7 a. m. 50.		Midnight 20.		*Clearing 9 a. m.*
Aug. 18	3 p. m.		78, 29.92	S. mod.	Flow.	7 p. m. 70.		Noon 20.		
Aug. 19	7 a. m.		69, 30.00	S. W. mod.	High flow.	8 a. m. 40.	18–82	2 a. m. 12.		Humid day
Aug. 19	3 p. m.		80, 30.00	S. lt.	Low flow.	8 p. m. 67.		2 p. m. 10.		Phosphorescent night.
Aug. 20	7 a. m.		70, *30.00*	S. W. mod.	High flow.	*8:30 a. m. 50.*		*3 a. m. 13.*		
Aug. 20	3 p. m.		80, 29.98	S. W. str.	Low.	9 p. m. 74.		3 p. m. 10.		Windy day and night.
Aug. 21	7 a. m.		70, 29.93	S. W. str.	Flow.	9:30 a. m. 57.		4 a. m. 12.		Thunder storm 5 p. m.
Aug. 21	3 p. m.	Threatens.	78, 29.81	S. W. str.	Low ebb.	10 p. m. 67.		4 p. m. 12.		Rain .28 in. N. W. 7 p. m.
Aug. 22	7 a. m.	*Hazy.*	62, 29.97	N. W. lt.	Low flow.	10:30 a. m. 64.		5 a. m. 17.		Calm to noon.
Aug. 22	3 p. m.		75, 30.00	N. E. str.	Low ebb.	10:30 p. m. 76		5 p. m. 19.		
Aug. 23	7 a. m.		60, 30.03	S. W. lt.	Low flow	11 a. m. 68	18–80	6 a. m. 22.		Calm last night.

Table Ia—Climatic Data Pertaining to Oyster Propagation, Edge Cove, 1914. (Continued)

Date.	Hour.	Sky R.	Tem.	Bar.	Wind F.	Tide Ht.	High Hr.	Den. Tem.	Low Hr.	Den. Tem	Miscellaneous.
S.	3 p. m.		75,	29.84	S. mod.	Ebb.	Midnight 68.		6 p. m. 20.		S. E. strong after sunset.
Aug. 24	7 a. m.		75,	29.78	W. lt.	Low.	Midnight 68.		7 a. m. 16.		
Aug. 24	3 p. m.		86,	29.70	S. W. lt.	Ebb.	1 p. m. 65		7 p. m. 22.		Thunder storm 7 p. m.
Aug. 25	7 a. m.	Rain.	57,	30.12	N. E. mod.	Low.	1 a. m. 66.	19–74	7:30 a. m. 19.		Rain *all night*; .57 *inches 8 a. m.*
Aug. 25	3 p. m.	Clearing.	65,	30.12	E. str.	High ebb.	1:30 p. m.		7:30 p. m.		Tide gage on strike.
Aug. 26	7 a. m.	Cloudy.	60,	30.20	E. gale.		2 a. m.		8 a. m.		Calm last night.
Aug. 26	3 p. m.	Cloudy.	68,	30.19	E. mod.		2 p. m		8 p. m.		East gale at day break.
Aug. 28	6 a. m.	Cloudy.	72		S. E.		4 a. m.		10 a. m.		Tide gage on strike.
Aug. 28	3 p. m.	Rain.	70		S. E.	Flow.	4 p. m.		10:30 p. m. 20.		Rain into night, 1.08 inches.
Aug. 29	6 a. m.	Cloudy.	72		Calm.	High ebb.	4:30 a. m. 54		10:30 a. m. 20.		Tide gage approximate.
Aug. 29	12:30 p. m.		84		S. E. mod.	Flow.	4:30 p. m. 64.		11:30 p. m. 10.		10 p. m. 79, threatens.
Aug. 30	7:10 a. m.		72		N. W. lt.	Ebb.	5 a. m. 40.		Midnight 10.		Approx.
S.	1 p. m.	Cloudy.	79		N. W. lt.	Flow.	6 p. m. 56.		11:30 a. m. 0.		Approx.
Aug. 31	6:30 a. m.		68		N. W. lt.	High.	6 a. m. 35.	18–78	1 a. m. 6.		Approx.
Aug. 31	1 p. m.		88		W. lt.	Low flow.	6 p. m. 55.		Noon. 0.		Approx. calm evening.
Sept. 1	6 a. m.		70		S. W. lt.						Tide gage on strike.
Sept. 1	6:30 p. m.		82		S. E. mod.		8 p. m. 60.				
Sept. 2	6:30 a. m.		76		S. W. lt.		8:30 a. m. 35.	20–73	3 a. m. 10.		Approx.
Sept. 2	2 p. m.		88		S. W. mod.		9 p. m. 55.		3 p. m. 0.		Approx.
Sept. 3	7:30 a. m.		76		N. lt.		9:30 a. m. 40.		4 a. m. 0.		Approx.
Sept. 3	12:30 p. m.	Hazy.	82		S. W. lt.		9:30 p. m. 70.		4 p. m. 10.		Approx.
Sept. 4	7 a. m.		62,	29.01	Calm.						Tide gage on strike.
Sept. 4	3 p. m.	Cloudy.	77,	30.00	N. W. mod.		10 p. m. 55.		5 p. m. 10.		Approx.
Sept. 5	7 a. m.		47,	30.08	Calm.		10:30 a. m. 55.	19–77	5:30 a. m. 10.		Approx.
Aug. 5	3 p. m.		70				10:30 p. m. 52.		5:30 p. m. 8.		Approx.
	7:30 a. m.		64,	29.33	Calm.		11 a. m. 52.		6 a. m. 9.		Approx.
S.	3 p. m.	Cloudy.	73		S. W. str.		11 p. m. 55.		6 p. m. 5.		Approx. S. W. str. began 9 a. m.
Sept. 7	5:30 a. m.	Cloudy.	70,	29.85	W. lt.		11 a. m. 50.		6 a. m. 8.		Approx.
Sept. 7	3 p. m.		80,	29.82	N. W. mod.		1 p. m. 49.		6 p. m. 10.		Approx.
Sept. 8	7 a. m.	Cloudy.	57,	30.03	N. lt.						Tide gage off. Rain 8 a. m.
Sept. 8	3 p. m.	Clearing.	68,	30.00	N. lt.				6 p. m. 10.		Tide gage off. Rain .60 inch.
Sept. 9	7 a. m.	Cloudy.	43,	30.20	N. lt.						Tide gage off. 39 at 6 a. m.
Sept. 9	3 p. m.		64,	30.20							Tide gage off
Sept. 10	7 a. m.		52,	30.26	N. lt.						37 deg. at 6 a. m.
Sept. 10	4:30 p. m.		64,	30.16	E. mod.		1:30 p. m.	20–64			
Sept. 11	7 a. m.	Hazy.	39,	30.06	Calm.			21–64			
Sept. 11	3 p. m.	Hazy.	67,	30.06							

§3—PLANKTON DATA.

Explanatory of Tables II and IIa.

Tables II and IIa show the records respectively at Barnegat and Tuckerton of the number and kinds of oyster fry found by filtering the sea water, and examining the residue with a microscope. The stations designated A, B and C at Barnegat were chosen, so that A was situated in the Lagoon near the Laboratory and near the mouth of the river. B was located near the old outlet of the Lagoon, while C is at the outlet into the Bay of the combined waters of the old outlet and the recently dug canal. These stations are situated at intervals of about a quarter of a mile. "Holl" represents a lot planted by G. W. Hollingsworth near A. "EBC" means East of Big Cat Island. "Ram" is the point nearest the Laboratory. "Cr" indicates the "river" above the Laboratory, and "Br" the part of the river near the bridge.

Stations A, B, C, D, E, etc., in Table IIa represent places in Edge Cove beginning at the mouth of Ezra Creek and extending out towards and upon the planting grounds. The figures connected with these letters represent substations indicated by oyster stakes ("whips") successively farther and farther out.

In the "Den Tem" column, the first number indicates the last two figures of the hydrometer reading (since the first two are always 10). Thus, 20 means 1020 (1000 representing pure fresh water). The second number shows the temperature of the water. The column headed "Fry Amt" shows first the number of oyster larvæ found, and secondly the quantity of water filtered. A blank space always indicates that the amount filtered was one-fifth of a bucket, or approximately one and a half liters (1500 c. c.). The word "net" shows that the fry were secured by towing the plankton net. Usually a count was not made in such cases, as an unknown quantity of water had passed through the net. The letter "b" indicates that an entire bucket of water was filtered, "h" indicates half a bucket, "th" a third of a hucket, "q" a fourth of a bucket, respectively.

In the following column the numbers of the fry are ranged under the sizes S (small), M (medium), and L (large). "f" simply means that fry of corresponding size were present, but their numbers were not determined. In the column headed "Clams" the number of clam larvæ found is entered, or is indicated by "c." Other larvæ are also indicated: "urns" represents an undetermined species of *Tintinnus*.

In the "Sed't" column, has been indicated the amount of dirt, etc., suspended in the water, which usually depends on the strength of the wind, and the tidal currents. In the "miscellaneous" column we indicate the number of fry reduced to the fifth bucket ratio, and also make explanatory and supplementary notes to the previous columns.

Distribution of Oyster Fry.

By oyster fry we mean the swimming embryos or larvæ that result from the hatching of the developing oyster eggs. We are very anxious

to learn two things from the distribution of these fry. First, at what date were the eggs spawned out of the mother oysters, and how fast do they grow, so we may predict when they will be ready to set as spat. Second, how do these fry behave in respect to the tidal currents, so they will not be lost by being carried to sea, and at the same time succeed in effecting their own distribution. The first question is relatively easy to solve, and we have made good progress in its solution, but the second is still quite obscure If we could always have calm weather, this point would be quickly determined, but unfortunately we rarely have such weather. The fry make special responses to the state of agitation of the waves, to the amount of sunshine, to temperature, etc., but these by themselves would not be so bad. The trouble is that the agitation of the water stirs up mud which we do not know how to separate from the fry, and so it interferes with the determination of their number. Very possibly the same agitation that raises the mud raises the fry also, when they would rather stay at the bottom.

On counting the fry in the water from day to day, we find great variations in the numbers. Do these fluctuations represent an actual fact in the behavior of the fry, or are we dealing with totally different lots of fry, produced at different places, and carried successively by currents to the points where we see them? We believe that both these things are true. The difficulty arises in determining how much to attribute to each factor. If the latter should be preponderately true, then our findings cannot so easily be compared with one another, as when we are dealing with the same lot of fry all the time.

Under these circumstances, the best that can he done is to select the highest number of fry found each day and analyze it into its component broods, which may be as many as three or four, according to the number of warm waves that have stimulated the spawning activities of the oysters. Then we determine the rate of growth of each brood, keeping tab on the largest brood. This is likely to produce the principle "set" of spat, upon a date that can be predicted with tolerable accuracy, although the exact effect of temperature in hastening the growth of the fry has still to be established; only an approximate knowledge of this is as yet available. In the cold Canadian waters, Dr. Stafford has determined the free swimming period to be four weeks. In our waters early in the season we found it to be three weeks. Some of the broods in waters that reach or exceed 80 degrees in warmth, undoubtedly mature in less than two weeks and it looks possible that the period may in southern waters be as short as a week.

At Barnegat we found fry already in the water, with both a brood of small and one of medium size, by the middle of June. The hot wave of the 25th, not only set free a new brood of fry whose presence became evident on the 30th, but caused the large survivors of the previous broods to "set." By consulting the Chart Plate I we find that there was also manifested a large brood of medium fry on the 30th, which might possibly be the same as the brood of small fry seen on the 26th, as the water

was extra warm at this time. Quite a small number of large fry was found throughout July; but larvæ of smaller size disappeared gradually during a period when the water became decidedly colder. On July 18th a warm wave brought into view two broods of limited numbers, one small and one of medium size; and during the succeeding warm days large fry were present and "setting" as spat. No further broods of fry appeared after the close of July. For purposes of corroboration we must bear these facts in mind when we later in this report consider the spawning and spatting observations.

Now let us turn to our data secured at Edge Cove. Here we found few fry until the 19th of July, when there were small, medium and a few large fry present. From this time on to the third of August, during a warm spell, we found increasing numbers of small fry in the water, but fewer medium ones, and very few large ones, indicating a great mortality of these earlier broods. Later in August, beginning the 19th, in the midst of another warm period, we again have a modest showing of fry, in all three sizes, which continues with gradual decrease into September.

The number of fry at the most favorable showing did not equal more than half that found in other years, and they were distributed throughout the season more generally, being spread "thin" as it were. There also is good evidence of a greater mortality among them than usual. Comparing Barnegat and Tuckerton, we find that oyster propagation was later in the latter region than in the former. As the water was warmer at Tuckerton than at Barnegat, this seems anomalous. Further discussion of these matters is deferred to later sections of this report. The proportion of clam fry was, as usual, greater at Tuckerton than at Barnegat.

Table II—Plankton Data Pertaining to Oyster Propagation, Barnegat, 1914.

Date.	Hour.	Tide.	Place.	Den.Tem.	Fry Amt.	S. M. L.	Clams, Etc.	Sed't Etc.	Miscellaneous.
June 14.	1:30 p. m.	High flow	A.	20–68	+ net.	F. F.		Much.	Many fry, 4 hauls.
June 14.	2 p. m.	*High.*	B.	18–60	+ net	F. F.	Some.	Much.	Fewer; 4 hauls
June 14.	2:15 p. m.	High ebb.	C.	19–68	+ net.	F. F. 1	Some	*Much.*	Many fry; 4 hauls
June 15.	3 p. m.	High flow.	A.	18–72	61	F. 1			Dipper used
June 15.	3:15 p. m.	*High.*	B.	18–72	13	F.	2.		Near medium size
June 15.	3:30 p. m.	High ebb.	C.	19–72	29	F.			*Near medium.*
June 16.	6:30 p. m.	High ebb.	A.	18–62	13	F. 1			
June 16.	6:45 p. m.		B.	18–62	16	F.			
June 16.	7 a. m.		C.	19–62	28	F.			
June 17.	9 a. m.	High ebb.	A.	16–70	3	F.			
June 17.	9:15 a. m.		B.	17–70	5	F.			
June 17.	9:30 a. m.		C.	18–70	12	F.			
June 17.	5 p. m.	High flow.	A.	17–68	4	F.		Much.	
June 17.	5:15 p. m.		B.	17–68	3	F.		Much.	
June 17.	5:30 p. m.		C.	18–66	2	F.		Much	
June 18.	9:45 a. m.	High ebb.	A.	16–74	18 net.	F.		Much.	
June 18.	10 a. m.		B.	16–74	*21 net.*	F.		Much.	
June 18.	10:15 a. m.		C.	16–72	111 net.	F.		Much.	
June 18.	*5 p. m.*	High flow.	A.	18–69	65 net.	F.	1	Much.	
June 18.	5:15 p. m.		B.	18–69	*11* net.	F.	2	Much.	
June 18.	5:30 p. m.		C.	18–69	176 net.	F. 11, 3		Much	Less salt than A, B.
June 19.	*9:45 a. m.*	*Low ebb.*	A.	16–74	24	21			
June 19.	10 a. m.		B.	16–74	3	1, 2,			
June 19.	10:15 a. m.		C.	17–72	35	6, 29,			
June 20.	3:15 p. m.	*Low flow.*	A.	15–74	4	1, 3,			
June 20.	3:30 p. m.		B.	17–72	2	1, 1,			
June 20.	3:45 p. m.		C.	17–72	13	1, 12,			
June 22.	7 a. m.	3 ebb.	A, 1.	14–68	7	5, 2,	Snails.		Raining
June 22.			A, 2.	14–68	9	4, 5,	Snails.		*Raining*
June 22.	8:30 a. m.	3 ebb.	A.	18–70	1	1	Copepods	Much	
June 22.			B.	17–70	6	6,	Copepods	Some	
June 22.			C.	17–70	4	3, 1	Snails	Some	Copepods.
June 23.	8:45 a. m.	5 flow.	A.	17–70	13	11, 2	Copepods	Little	
June 23.			B.	*17–70*	1	1	Copepods	Little.	Many copepods
June 23.			C.	17–70	5	5.	Snails	Some	
June 23.	11 a. m.	4 ebb.	A, 1.	15–73	0			Little.	
June 23.			A, 2.	16–74	4	4		Little.	
June 23.			A, 3.	16–74	2	2		Little	
June 23.	*4 p. m.*	1 flow	A.	15–76	3	1, 2,	Snails.	Little	Many snail larvae.
June 23.			B.	16–76	5	1, 4,		Little.	Few snails.
June 23.			C.	17–76	0			Little.	Few snails.

Table II—Plankton Data Pertaining to Oyster Propagation, Barnegat, 1914. (Continued)

Date.	Hour.	Tide.	Place.	Den. Tem.	Fry Amt.	S. M. L.	Clams, Etc.	Sed't Etc.	Miscellaneous.
June 23.	6 p. m.	3 flow.	A, 1.	14–75	3	3		Little	
June 23.			A, 2.	14–75	2	2		Little	
June 23.			A, 3.	14–75	1	1		Little.	
June 24.	10 a. m.	7 ebb.	A.	15–79	6	5, 1		Little.	
June 24.			B.	16–79	9	5, 4		Little.	
June 24.			C.	17–78	6	1, 4, 1			
June 25.	7:20 a. m.	6 flow.	A.	16–78	13	12, 1	Urns.		Many peridinas, ceratium.
June 25.			B.	16–78	15	14, 1	Urns.		Many peridinas, ceratium.
June 25.			C.	17–77	9	3, 6	1 Urns.		Many peridinas, ceratium.
June 25.	5:20 p. m.	3 ebb.	A.	14–84	11	6, 1, 4	1	Urns	Many peridinias
June 25.			B.	15–84	106	98, 2, 6	4	Urns.	Many peridinias
June 26.			C.	16–82	11	4, 3, 5	2	Urns	Many peridinias
June 26.	7:30 a. m.	Flow.	A.	17–77	41	36, 5	5		
June 26			B.	17–76	65	60, 3, 2	8		
June 26.			C.	18–76	3	3		Much.	
June 26.	11:30 a. m.	6 ebb.	B, 1.	17–82	231	215, 16	2 Urns	Copepods.	B, 1, Cox's Cove.
June 26.			B, 2.	17–82	202	201, 1, 1	Urns.		B, 2, S. of Cox's Cove.
June 26.			B, 3.	17–80	39	39	1 Urns.	Much.	B, 3, E. of Cat Island
June 26.	4 p. m.	Ebb.	A, 1.	12–83	19	19	Few	Little	A, 1, East of Holling plot.
June 26.			A, 2.	15–83	38	26, 9, 3		Little.	A, 2
June 26.			A, 3.	15–83	5	5		Little.	A, 3, West of Big Cat Island
June 26.	4:30 p. m.	3 ebb.	A.	15–82	11	6, 5	Urns	Little	
June 26.			B.	16–82	215	201, 10, 4	Urns	Little.	
June 26.			C.	16–80	48	28, 20	Copep.	Little	
June 27.	8:30 a. m.	Flow.	A.	16–77	22	21, 3	Copep	Little	
June 27.			B.	16–76	25	16, 9	2 Urns	Little.	
			C.	17–76	12	9, 2, 1	Urns	Little.	
June 29.	7:30 a. m	Ebb	A.	15–75	45	31, 11, 3	Urns	Little.	
June 27.			B.	16–75	39	20, 16, 3	Urns	Little.	
June 27.			C.	17–76	64	43, 20, 1	Urns	Little.	Also snails
June 29.	6 p. m.	10 Ebb.	A.	16–78	121	96, 22, 3	Urns	Little.	
June 29.			B.	17–77	99	45, 50, 4	Urns	Little.	
June 29.			C.	16–76	37	11, 26	Urns	Little.	
June 30.	7:45 a. m.	8 ebb.	A.	17–68	131	31, 98, 2	Urns	Little.	
June 30.			B.	17–68	181	83, 94, 3	5 Urns	Little.	
June 30.			C.	17–68	52	10, 36, 6	3 Urns	Little.	
June 30.	5 p. m.	10 ebb.	A.	16–75	23	6, 12, 5	4 Urns	Little.	
June 30.			B.	17–76	341	28, 311, 2	Urns	Little.	
June 30.			C.	17–75	94	44, 50	Urns	Much.	
July 1	8 a. m.	Ebb.	A.	14–74	11	8, 3	Urns	Much.	
July 1.			B.	16–74	61	42, 19	Urns	Little.	
July 1.			C.	16–74	33	21, 12	Urns	Much.	

Table II—Plankton Data Pertaining to Oyster Propagation, Barnegat, 1914. (Continued)

Date.	Hour.	Tide.	Place.	Den. Tem.	Fry Amt.	S.	M.	L.	Clams, Etc.	Sed't Etc.	Miscellaneous.
July 1	11:30 a. m.	3 ebb.	Lab.	08-76	6	6			No snails.	Much.	S. str cloudy, few urns, copepods.
July 1	6:30 p. m.	9 Flow	A.	16-69	53	21	31	1		Diat.	Rain.
July 1			B.	16-70	84	18	66		4		Rain.
July 1			C.	17-70	117	45	71	1	Urns	Much.	Rain.
July 2	8 a. m.	8 ebb.	A.	16-72	103	18	81	4		Little.	
July 2			B.	16-72	16	3	11	2	2	Little.	
July 2			C.	17-72	114	52	62			Much.	
July 4	7:30 a. m.	10 ebb.	A.	17-66	21	17	4			Little.	*Few snails*
July 4			B.	17-66	26	18	8		1	Little.	Few snails.
July 4			C.	18-67	8	7	1		2	Little.	Few snails.
July 6	7:35 a. m.	12 flow.	A.	16-68	19	12	7			Little.	
July 6			B.	17-68	21	19	2			Much.	Too nuch silt to count.
July 6			C.	17-68	8					*Much.*	*Too much silt to count.*
July 7	6:30 a. m.	11 flow.	A.	16-64	3		1	2	Few snails.	No urns.	Cloudy.
July 7			B.	16-61	1		1		Few snails.	No urns.	Near rain.
July 7			C.	17-64	5	2	2	1	Few snails.	No urns	Rain.
July 8	7 a. m.	8 flow.	A.	11-71	5	3	2		Few snails	No urns.	
July 8			B.	14-71	3		3		*Few snails*	*No urns*	
July 8			C.	17-70	2		2		Few snails	No urns	
July 8	2 p. m.	6 ebb.	Cat. Ids	16-75	0						
July 8			Shad Pt.	15-75	2		2				
July 8			C.	16-75	4	1		3			
July 9	6:30 a. m.	6 flow.	A	15-72	3	2	1		Copepods		
July 9			B.	15-72	2	2			Copepods.		
July 9			C.	16-71	6	6					
July 10	Noon.	10	B.		Few, net.				Copepods.		
July 10	6 a. m.	6 flow.	A.	14-72	0				*Snails*		
July 10			B.	15-72	4	4			*Snails*		
July 10			C.	15-72	3	3			Snails.		
July 11	7:50 a. m.	7 flow.	A.	16-72	2 b.	1	1		Snails		"b" Entire bucketful filtered.
July 11			B.	16-72	0 b.				Snails		"b" All filtered
July 11			C.	15-72	0 b.					Much	"b" All.
July 13	7:45 a. m.	8 flow.	A.	14-74	*19 b.*	18		1			4 fry; few copepods; no snails.
July 13			B.	15-73	14 b.	13		1			3 fry; few copepods; no snails.
July 13			C.	15-74	9 b.	8	1				2 fry; few copepods; no snails.
July 13	7 p. m.	7 ebb.	A.	11-78	10 b.	9	1			Much	2 fry; no clams; no snails.
July 13			B.	14-78	4 b	4				Little.	1 fry; few snails.
July 13			C.	15-78	2 b	2					0 fry; few snails.
July 14	6:20 a. m.	8 flow.	A.	15-76	0 b.						Few snails.
July 14			B.	16-76	13 b.	8	3	2	2	Diatoms.	3 fry; many snails, diatoms.
July 14			C.	16-76	19-b.	14	4	1		Much.	4 fry; diatoms.
July 14	10:20 a. m.	6 ebb	Barnegat.	12-77	8 b	2	5	1		Little	2 fry; Holling lot; diatoms.

Table II—Plankton Data Pertaining to Oyster Propagation, Barnegat, 1914. (Continued)

Date.	Hour.	Tide.	Place.	Den. Tem.	Fry Amt.	S. M. L.	Clams, Etc.	Sed't. Etc.	Miscellaneous.
July 14	2:45 p. m.	11 flow	A.	15–76	9 b.	6, 2, 1		Little.	2 fry; diatoms.
July 14			B.	15–76	1 b.	1			0 fry.
July 14			C.	15–76	0 b.				Raining.
July 15	6:45 a. m.	8 ebb.	A.	09–74	4 b.	4		Little	1 fry.
July 15			B.	11–74	1 b.	1,		Little.	0 fry.
July 15			C.	14–75	9 b.	7, 2		Little.	2 fry.
July 15	1:15 p. m.	10 flow.	A.	14–78	3 b	3		Little.	1 fry; few copepods
July 15			B.	15–78	4 b.	3, 1		Little.	1 fry; few copepods.
July 15			C.	15–77	9 b.	9			2 fry; very rough; few copepods.
July 16	6:45 a. m.	5 ebb.	A.	13–79	12 b	8, 4			3 fry; few copepods.
July 16			B.	14–79	8 b.	5, 3			2 fry; few copepods
July 17			C.	14–79	4 b.	1, 2, 1			1 fry;
July 17	7:45 a. m.	6 ebb.	A.	14–80	38 b.	31, 7	Urns		8 fry; few copepods
July 17			B.	14–80	61 b.	57, 4	3 Urns		12 fry.
July 17			C.	15–80	83 b.	83	Urns		16 fry.
July 17			C, 1.	15–80	132 b.	128, 4	Urns		26 fry; C, 1, Mouth creek.
July 17	1:30 p. m.	1.5 ebb.	Holl.	09–84	12 b.	12		Much.	2 fry; dirt spoils count.
July 17	7:45 p. m.	9 flow.	A.	14–80	16 b.	16		Much.	3 fry; dirt spoils; wind died.
July 17			B.	11–80	42 b.	33, 9		Much	8 fry; dirt spoils count; wind died.
July 17			C.	16–80	274 b.	272, 2		Much.	55 fry; dirt spoils count; wind died.
July 17			C, 1.	16–80	181 b.	151, 30		Much.	36 fry; dirt spoils count; wind died.
July 18	7 a. m.	6 ebb.	A.	14–80	64 b.	51, 13		Much.	13 fry.
July 18			B.	14–80	86 b.	40, 46		Much.	17 fry.
July 18			C.	15–80	216 b.	121, 95		Much.	43 fry.
July 18			C, 1.	15–80	201 b.	68, 133		Much.	40 fry.
July 18	3 p. m.	5 flow.	A.	13–86	18	6, 12		Little.	
July 18			B.	14–86	55	41, 14		Little.	
July 18			C.	15–85	126	46, 80		Little.	
July 18			C, 1.	15–85	141	62, 79		Little	
July 20	6:30 a. m.	4 flow.	A.	16–70	9	3, 6		Little.	Few copepods.
July 20			B.	16–70	18	5, 12, 1		Little.	Few copepods.
July 20			C.	16–70	32	16, 14, 2			Few copepods; few urns.
July 21	7:30 a. m.	2 ebb.	A.	15–74	11	9, 2			
July 21			B.	15–74	3	3		Much.	
July 21			C.	15–74	13	7, 4, 2		Much.	
July 22	8 a. m.	9 flow.	A.	17–73	4	4,		Much.	Too much silt for proper count.
July 22			B.	17–73	13	8, 4, 1		Much.	
July 22			C.	18–73	1	1			
July 22	3:30 p. m.	Low.	Bec.	16–80	2	2		Much.	Bec. East of Cat Island.
July 23	7:30 a. m.	2 flow.	A.	15–74	3 h.	3		Some.	1 fry.
July 23			A, 1.	15–74	1 h.	1		Some.	0 fry; East of Big Cat Island.
July 23			B.	16–74	2 h.	2		Some.	1 fry.

Table II—Plankton Data Pertaining to Oyster Propagation, Barnegat, 1914. (Continued)

Date.	Hour.	Tide.	Place.	Den. Tem.	Fry Amt.	S. M. L.	Clams, Etc.	Sed't. Etc.	Miscellaneous.
July 23.			C.	17-74	6 h.	1, 3, 2			2 fry.
July 24.	7:10 a. m.	6 flow.	A.	18-72	9	4, 5		Much.	9 fry; silt spoils count.
July 24.			B.	17-72	Few.	F.		Much.	Silt spoils count.
July 24.			C.	18-72	Few.	F.		Much.	Silt spoils count.
July 25.	12:20 p. m.	11 flow.	A.	18-76	Few net.			Much.	Few copepods.
July 25.			B.	18-76	Many, net.	2		Much.	
July 25.			C.	18-76	Many, net.	1		Much.	
July 27.	7:30 a. m.	8 flow.	A.	16-78	4	4			
July 27.			B.	16-78	1	1			
July 27.			C.	16-78	2	2			
July 27.	8:30 a. m.	8 flow.	Ram.	15-78	3	2, 1			Rain, off Lab. Pt.
July 27.			H. E.	15-78	0				H. E. East of Holling lot.
July 27.			E. B. C.	16-78	8	6, 2			E. B. C. East of Big Cat Island.
July 27.	3:45 a. m.	10 ebb.	A.	16-80	Many, net.	F. M. 2	Snails.	Much.	Many snail larvae.
July 27.			B.	16-80	Few, net.	F.	Snails.	Much.	Many snail larvae.
July 27.			C.	17-80	Many, net.	F. M.	Snails.	Much.	Many snail larvae.
July 28.	1:45 p. m.	14 flow.	A.	16-72	42 net.	1, 38, 3	Snails.		Rain.
July 28.			E. B. C.	16-72	7 net	7	Snails.		Rain.
July 28.			B.	16-72	17 net.	16, 1	Few snails		Rain.
July 28.			C.	17-72	10 net.	2, 6, 2	Few snails.		Rain.
July 28.	2:30 p. m.	High.	Ram.	15-76	6 b.	6	Medusae.		1 fry.
July 28.			Cr.	15-76	2 b.	2	Medusae.		0 fry; Cr. from Lab. towards bridge.
July 29.	6:30 a. m.	11 flow.	Ram.	15-67	3 b.	1, 2	Few snails	Little.	1 fry.
July 29.			Cr.	12-67	13 b.	2, 11	Few snails.	Little.	3 fry.
July 29.			Br.	11-67	0 b.		Few snails	Little.	0 fry; Br. near bridge.
July 29.			Hol.	15-67	2 b.	2	Few snails.	Little.	0 fry; Hol. lot near Ram
July 29.	7:45 a. m.	12 flow.	A.	16-66	8 net.	4, 3, 1	Snails.	Much.	
July 29.			E. B. C.	17-66	10 net.	2, 7, 1	Snails.	Much.	
July 29.			B.	16-66	2 net.	4, 8	Snails.	Much.	
July 29.			C.	17-66	6 net.	1, 5	Few snails.	Much.	
July 29.	11:55 a. m.	14 flow.	Hol.	14-72	2 b.	2	Few snails.	Much.	0 fry.
July 29.			H. C.	15-72	4 b.	4	Few snails.	Little.	1 fry; H. C. Holling to Cat Island.
July 29	6:10 p. m.	14 ebb.	A.	17-68	4 b.	4	Snails.	Little.	1 fry.
July 29.			E. B. C.	17-68	2 b.	2	Snails.	Little.	0 fry.
July 29.			B.	17-68	1 b.	1	Snails.	Little.	0 fry.
July 29.			C.	18-68	0 b.		Few snails	Little.	
July 30.	6 a. m.	13 flow.	Hol.	14-68	0 b.		Snails.	Much.	
July 31.	7 a. m.	15 ebb.	A.	15-62	0 b.		Snails.	Much.	
July 31.			B.	16-62	2 b.	2	Snails.	Much.	
July 31.			C. 1.	16-62	0 b.		Snails.	Much.	
July 31.			C.	17-62	1 b.	1	Snails.	Much.	
July 31.			Ram.	13-62	0 b.		Few snails.	Much.	Ram. Lab pt.

Table II—Plankton Data Pertaining to Oyster Propagation, Barnegat, 1914. (Continued)

Date.	Hour.	Tide.	Place.	Den.Tem.	Fry Amt.	S.	M.	L.	Clams, Etc.	Sed't, Etc.	Miscellaneous.
July 31	8:10 a. m.	13 ebb.	Cr.	11–64	0 b.				Few snails.	Much.	
July 31			Br.	10–64	0 b.					Much.	
July 31	11:45 a. m.	12 ebb.	A.	14–70	Few, net.			2	Snails.	Much.	
July 31			B.	15–70	0 net.				Few snails.	Much.	
July 31			C.	15–70	1 net.	1			Few snails.	Much.	Rough.
Aug. 1	7:45 a. m.	9 ebb.	A.	15–68	0 net.				Snails.	Much.	
Aug. 1			B.	15–08	2 net.	1		1	1 snail.	Much.	Urns.
Aug. 1			C.	16–68	1 net.	1			Urns.	Much.	Urns.
Aug. 1			Hol.	14–69	0 net.				Few snails.	Much.	
Aug. 1	9:30 a. m.	8 ebb.	Cr	10–73	0 net.				Few snails.	Much.	
Aug. 1			Br.	06–73	2 net.	2			Few snails.	Much.	
Aug. 1	8:30 a. m.	9 ebb.	Ram.	12–68	0 net.				Few snails.	Much.	
Aug. 3	11:30 a. m.	6 ebb.	Ram.	11–77	0 b.					Little.	
Aug. 3	1:15 p. m.	5 ebb.	A.	13–82	0 b.					Little.	
Aug. 3			B.	14–82	0 b.					Little.	
Aug. 3			C, 1.	15–82	0 b.					Little.	
Aug. 3			C.	15–81	0 b.						
Aug. 6	6:30 a. m.	11 flow.	A.	14–74	0 b.				Few snails.	Much.	
Aug. 6			B.	15–74	2 b.		2		Few snails	Much.	
Aug. 6			C.	15–74	0 b.				Few snails.	Much.	
Aug. 7	1:20 p. m.	2 ebb.	A.	13–81	1 b.	1			1, few snails.	Much.	
Aug. 7			B.	14–81	0 b.				Few snails.	Much.	
Aug. 7			C.	14–81	0 b.				Few snails.	Much.	
Aug. 8	6 a. m.	5 flow.	A.	14–76	2 b.		2		Few snails.	Little.	
Aug. 8			B.	14–76	1 b.	1			1, few snails.	Little.	
Aug. 8			C.	15–76	4 b.	2,	1,	1	Few snails	Little.	
Aug. 10	8:30 a. m.	2 ebb.	A.	15–81	0 net.				No snails.	Little.	
Aug. 10			B.	15–81	0 net.				No snails.	Little.	
Aug. 10			C.	16–81	6 net.	1,	5		No snails	Little.	
Aug. 11	6:45 a. m.	2 ebb.	A.	14–76	0 net.					Much.	
Aug. 11			B.	15–76	0 net.					Much.	
Aug. 11			C.	16–76	0 net.					Much.	
Aug. 13	7 a. m.	4 ebb.	A.	13–69	2 net.	2				Much.	
Aug. 13			B.	12–69	3 net.	2,	1			Much.	
Aug. 13			C.	16–70	0 net.					Much.	
Aug. 14	8 a. m.	3 ebb.	A.	10–72	0 net.					Little.	
Aug. 14			B.	12–72	2 net.	1,	1			Little.	
Aug. 14			C.	13–72	5 net.	2,	3			Little.	
Aug. 15	6 p. m.	10 flow.	A.	14–78	7 b.	6,	1		Few copep.	Little.	
Aug. 15			B.	15–78	4 b.	2,	1,	1		Little.	
Aug. 15			C.	16–79	3 b.	3				Little.	
Aug. 17	6 a. m.	4 ebb.	A.	12–71	4 b.	3,	1			Little.	

Table II—Plankton Data Pertaining to Oyster Propagation, Barnegat, 1914. (Continued)

Date.	Hour.	Tide.	Place.	Den. Tem.	Fry Amt.	S.	M.	L.	Clams, Etc.	Sed't, Etc.	Miscellaneous.
Aug. 17.			B.	12–71	1 b.		1			Little.	
Aug. 17.			C.	14–71	6 b.	6				Little.	
Aug. 18.	4:25 p. m.	4 flow.	A.	11–84	1 b.			1		Little.	
Aug. 18.			B.	14–84	0 b.					Little.	
Aug. 18.			C.	16–84	0 b.				1	Little.	
Aug. 19.	7 a. m.	5 flow.	A.	13–80	2 b.	2				Little.	
Aug. 19.			B.	13–80	1 b.	1				Little.	
Aug. 19.			C.	14–80	0 b.					Little.	
Aug. 20.	10 a. m.	8 flow.	A.	14–86	0 b.					Little.	
Aug. 20.			B.	13–86	1 b.		1			Little.	
Aug. 20.			C.	15–86	2 b.		2			Little.	
Aug. 21.	7:40 a. m.	7 flow.	A.	13–78	0 b.					Little.	
Aug. 21.			B.	13–78	0 b.					Little.	
Aug. 21.			C.	15–78	2 b.		2			Little.	
Aug. 22.	7:10 a. m.	9 flow.	A.	15–74	1 b.	1				Little.	
Aug. 22.			B.	15–74	0 b.					Little.	
Aug. 22.			C.	17–74	0 b.					Little.	
Aug. 23.	8 a. m.	8 flow.	A.	14–77	0 b.					Much.	
Aug. 23.			B.	15–77	1 b.	1				Much.	
Aug. 23.			C.	17–77	0 b.					Much.	
Aug. 24.	9 a. m.	10 flow.	A.	15–82	0 b.						
Aug. 24.			B.	15–82	0 b.						
Aug. 24.			C.	16–82	0 b.						
Aug. 25.	1:40 p. m.	14 flow.	A.	18–72	1 b.			1			
Aug. 25.			B.	17–72	0 b.						
Aug. 25.			C.	18–72	0 b.						
Aug. 26.	3 p. m.	12 flow.	A.	16–72	0 b.						Too much silt for count.
Aug. 26.			B.	17–72	0 b.						
Aug. 26.			C.	18–72	0 b.						
Aug. 27.	1 p. m.	10 flow.	A.	15–75	0 b.						
Aug. 27.			B.	16–75	3 b.	3					
Aug. 27.			C.	17–75	0 b.						
Aug. 28.	12:30 p. m.	7 flow.	A.	15–76	0 b.						
Aug. 28.			B.	15–76	3 b.	2,	1				
Aug. 28.			C.	16–76	4 b.	4,					
Aug. 29.	7:15 p. m.	16 flow.	A.	14–80	0 b.						
Aug. 29.			B.	14–80	0 b.						
Aug. 29.			C.	15–80	0 b.						
Aug. 31.	11 a. m.	7 ebb.	A.	13–79	0 b.						
Aug. 31.			B.	15–80	3 b.	2,	1				
Aug. 31.			C.	15–80	1 b.		1				
Sept. 2	8 a. m.	8 ebb.	A.	16–78	0 b.						

Table II—Plankton Data Pertaining to Oyster Propagation, Barnegat, 1914. (Continued)

Date.	Hour.	Tide.	Place.	Den. Tem.	Fry Amt.	S.	M.	L.	Clams, Etc.	Sed't. Etc	Miscellaneous.
Sept. 2			B	16–78	1 b.		1				
Sept. 2			C	17–78	2 b.	2			?		
Sept. 3	9 a. m.	6 ebb.	A	15–80	3 b.		3				
Sept. 3			B	13–80	1 b.	1					
Sept. 3			C	15–80	2 b.	1,	1		?		
Sept. 4	8:30 a. m.	10 flow.	A	15–75	0 b.						
Sept. 4			B	16–75	2 b.		2				
Sept. 4			C	17–75	0 b.						
Sept. 5	10 a. m.	10 flow.	A	16–74	0 b.						
Sept. 5			B	16–74	2 b.	2					
Sept. 5			C	17–74	3 b.	2,	1				
Sept. 7	8:40 a. m.	6 flow.	A	16–76	0 b.						
Sept. 7			B	16–76	2 b.		2				
Sept. 7			C	17–76	0 b.						
Sept. 8	4:30 p. m.	4 ebb.	A	17–69	0 b.					Much.	
Sept. 5			B	17–69	0 b.				1	Much.	
Sept. 8			C	18–69	0 b.					Much.	
Sept. 9	11 a. m.	6 flow.	A	18–66	2 b.	1,	1				
Sept. 9			B	18–66	0 b.						
Sept. 9			C	19–66	1 b.		1				
Sept. 10	2:30 p. m.	8 flow.	A	18–68	2 b.		2				
Sept. 10			B	18–68	0 b.						
Sept. 10			C	18–68	2 b.						

Table IIa—Plankton Data, Pertaining to Oyster Propagation, Edge Cove, 1914.

Date.	Hour.	Tide.	Place.	Den. Tem.	Fry Amt.	S. M. L.	Clams, Etc.	Sed't. Etc	Miscellaneous.
June 25	Noon	Ebb	A	19–85	0 net		Snails	Much	
June 26	1 p. m.	High ebb	B	20–80	0 b.				
June 27	6 a. m.	Low ebb	B, 1–7	20–76	Many, net	M.	Clams	Much	Long tow.
June 30	8 p. m.	Low ebb	A, B		net	15, 6	Snails		Calm after wind.
July 1	8 a. m.	Low	A, 4–9	20–73	b	1			Breeze begun.
July 2	10 a. m.	Low ebb	B, C	20–72	net	1, 7, 2	1		
July 2	6 p. m.	High ebb	B, 1	20–75	b.	?, 1			Ready to "set."
July 4	7:30 a. m.	Ebb	B, C	20–68	b.	3, 1			Ready to "set."
July 4	7:30 a. m.	Ebb	B, C		net	8, 2	Snails		
July 5	3:45 p. m.	Low flow	C	20–76	net		Urns		
July 5	4 p. m.	Low flow	B, C, D		net	1, 1, 1	2		Calm, long tow.
July 6	5 p. m.	Low	E	20–70	0 b				
July 7	4 p. m.	Low	E		0 b.				
July 9	10:30 a. m.	High flow	B, C	20–72	0 b.				
July 10	7:30 p. m.	Low flow	C	20–75	0 b.				
July 11	Noon	High neap	B, D	19–78	net.				Calm, very long tow.
July 12	*Noon*	High flow	B, C	21–80	6 b.	3, 3			1 fry.
July 12	6 p. m.	Low ebb	C	09–79	0 b.		Snails		Calm after storm
July 13	7:30 p. m.	Low flow	B, C	18–78	11 b.	8, 3			
July 15	6:30 a. m.	Ebb	C, D	18–76	net.	F. F.	Clams		Calm, long tow.
July 17	8:30 a. m.	Ebb	C	18–79	164 net.	140, 20, 4	Clams		Rough, long tow.
July 18	7:45 a. m.	Ebb	C, 4	19–80	35 h.	25, 10			14 fry; calm.
July 18			D, 4	19–80	12 h.	F.			
July 18	5 p. m.	High	C, 4	19–84	23 th.	20, 3	Clams		14 fry; rough, E. mod.
July 18			B, 6	18–84	12 th.	*10*, 2	*Clams*		7 fry.
July 19	3:30 p. m.	Flow	B	20–82	72 h.	26, 46	4	Little	30 fry
July 19			C	20–82	106 h.	42, 64	42		42 fry.
July 19	6 p. m.	High	B	19–79	121 q	80, 41	96		97 fry.
July 19			C	19–79	128 q.	92, 36	125		102 fry.
July 20	7 a. m.	High	B	20–74	53 q.	44, 9	24		42 *fry*
July 20	9 a. m.	Ebb	T. I.	15–80	42	30, 9, 3	6		42 fry; T. I Turtle Island; in lab
July 20	9:30 a. m.	Ebb	G. B.	16–80					G. B. Great Bay
July 20	7 p. m.	Flow	B	20–76	35	4, 30, 1			Windy.
July 20			C	20–76	18	7, 8, 3			Windy.
July 21	9:30 a. m.	Ebb	B	20–78	7	5, 2, 0			Too windy.
July 21			C	20–78	4	3, 0, 1			Too windy.
July 21	7:30 p. m.	High flow	B	19–78	7	2, 5, 0			Too windy.
July 21			C	19–78	2	1, 1, 0			Too windy.
July 22	8:30 a. m.	High ebb	B	20–76	5	5			
July 22			C	20–76	7	1, 6			
July 22	2:15 p. m.	Low ebb	B	19–78	2	2			M. may be clams
July 22			C	19–78	1	1			

Table IIa—Plankton Data, Pertaining to Oyster Propagation, Edge Cove, 1914—(Continued).

Date.	Hour.	Tide.	Place.	Den. Tem.	Fry Amt	S. M. L.	Clams, Etc.	Sed't Etc.	Miscellaneous.
July 22	8 p. m.	High flow	B.		1	1			
July 23	8 a. m.	High flow	B. C.		net.	F. F. F.			
July 23	5:30 p. m.	Low flow	B.	19–82	2	2			
July 24	9 p. m.	High	B.	20–82	56	55 1			Some near M.
July 25	6:30 a. m.	Low	B. C. D.	21–72	15	15			Some near M
July 25			B. C. D.		net	138 5	14.		
July 25	12:30 p. m.	High ebb	B.	20–77	56	55 1	C.		
July 25	5:30 p. m.	Low	Tank	77	4	4			
July 25			D, 4	19–78	13	13			Rough.
July 26	9 a. m.	Low flow	B. C.	19–78	10	10			Near calm, N. W
July 26	12:45 p. m.	High	B.	20–80	19	19	Snails.		N. W. light
July 26			C.		24	24			
July 26			D.	19–80	31	31			
July 26	6 p. m.	Low.	Tank.	21–80	3	3			
July 26	7 p. m.	Low.	C. D.	20–78	11	4, 6, 1	2		
July 27	9:30 a. m.	Low flow	B. C.	20–78	6	6			
July 27	1:15 p. m.	High	A. B. C.	20–81	216	216, F.	C.		Rough S. E
July 27			A. B. C.		net.	F. F. F.	C. urns.	Turds	Long haul.
July 27	7:45 p. m.	Low.	B.	20–80	140	118, 22	35.		N. E. light rain
July 28	10:30 a. m.	Flow.	B.	13–73		26, 1	1		Cloudy after rain
July 28	1:30 p. m.	High.	B.	19–78	172	169, 2, 1	16.		
July 29	1:30 p. m.	High.	B.	20–72	137	F. 131, 3	C.		Rough.
July 29	5:30 p. m.	High ebb	A. B. C. D.	20–75	62	F. 61, 1	2, snails		Calm.
July 29			A. B. C. D		net.		C.		Large number M. clams.
July 30	10 a. m.	Low.	Tank.	20–69		F. F.	C.		Many, like net haul
July 30	3 p. m.	High.	Mid.	20–70	113				
July 31	9 a. m.	Ebb.	Mid.	18–69	38	38			2 near L
July 31	3 p. m.	Low.	Mid.	19–70		F. F. 1			
July 31	6 p. m.	Ebb.	Mid.	20–74		2, 1			
Aug. 1	9 a. m.	Low.	C.	20–70	214 ?	212, 2			Counted by F F B.
Aug. 2	8 a. m.	High.	Mid.	20–72		? 1 ?			
Aug. 2	7 p. m.	High s.	Mid.		net.	M			
Aug. 2			Mid.		4				
Aug. 3	9 a. m.	High n.	Mid. B.	19–74	net.	5, M. 0			
Aug. 3			Mid. B.	19–74	9	8, 1	2.		
Aug. 3	8 p. m.	High s.	Mid. B.		400	400	20		After standing
Aug. 4	8 a. m.	High n.	Mid.		net.	F.	C.		Tenth of all are clams.
Aug. 5			Tank.		58	58	C.		
Aug. 8	8 a. m.	Low flow.	Tank.		18	F F.	C		
Aug. 8	9 a. m.	Low flow.	B.	18–77	F. net.	F. F.	C		S. W. light. M are near L
Aug. 9	9 a. m.	Flow.	B.	18–82	64	F. F.	C		Calm.
Aug. 9	1 p. m.	High.	B	19–82	9	9			S. W str.

Table IIa—Plankton Data, Pertaining to Oyster Propagation, Edge Cove, 1914—(Continued).

Date.	Hour.	Tide.	Place.	Den. Tem	Fry Amt.	S. M. I.	Clams, Etc.	Sed't Etc	Miscellaneous.
Aug. 11.			B.		F. net.	F. F	C.		1 large mactra.
Aug. 12.	*10:30 a. m.*	*Flow.*	B. C. D.	18-82	13 f.	F.			S. W. light.
Aug. 12.			B. C. D.		net.	F. F. F.	C.		
Aug. 13.	11:30 a. m.	Flow.	B.	18-80	30	F. F. 3	1		N. W. light
Aug. 14.	6 a. m.	High ebb.	B.	18-80	1	1			P. C. C. count.
Aug. 15.	Noon.	Flow.	D.	17-80		2, 1			
Aug. 16.	4 p. m.	High.	B.	18-79		4			
Aug. 17.	3 p. m.	flow.	D.	18-80	51	38, 5, 8	8.	Much.	
Aug. 18.	4 p. m.	High flow.	D.	17-82	83	63, 19, 1	0.	Much.	
Aug. 19.	7 p. m.	High.	B.	18-82	120	79, 32, 9	0	Much.	
Aug. 20.	7 p. m.	High.	C.	17-80	46	27, 14, 5	2.	Much.	
Aug. 21.	8 p. m.	High ebb.	B.	18-81	71	36, 31, 4	1.	Mod.	
Aug. 22.	*Noon.*	High ebb.	C.	18-80	76	59, 13, 4	1	Mod.	
Aug. 23.	10 p. m.	High flow.	B.	18-80	148	131, 11, 6	3.	*Little*	
Aug. 24.	2 p. m.	Ebb.	B.	18-72	113	79, 28, 6	0	Little.	
Aug. 25.	Noon.	*High.*	C.	19-74	167	124, 36, 7	0.	Much.	
Aug. 26.	Noon.	High.	C.	20-73	83	50, 21, 4	0	Much.	
Aug. 31.	7 p. m.	High.	C.	18-78	54	43, 7, 4	1	Much.	
Sept. 1.	8 p. m.	*High.*	C.	18-79	52	33, 19, 0	0	Much.	
Sept. 2.	Noon.	High ebb.	C.	20-73	44	31, 13, 0		Little.	
Sept. 4.	10 a. m.	High flow.	A.	18-78	55	39, 13, 3			Clear water, yesterday too muddy
Sept. 5.	*10:20 a. m.*	*High.*	A.	*18-75*	*23*	*12, 5, 6*			Pier, *Last night cold.*
Sept. 7.	Noon.	High.	C.	19-77	34	23, 7, 4			Last count P. C. C.
Sept. 9.	7 p. m.	Low.	B. C. D.		0 net.		Clams	Snails.	
Sept. 10.	Noon.	High.	B. C.	20-64	*0 net.*		C.		Cold last night
Sept. 11.	2 p. m.	High	Mid	21-64	0 net.				

§4 SPAWNING DATA.

Explanatory of Tables III and IIIa.

Tables III and IIIa exhibit data pertaining to the spawning of oysters at Barnegat, and at Tuckerton, respectively. As regards the place where the oysters were found, the following abbreviations obtain: "Anch," off Shad Point; "Cox," Cox's Cove; "E. L. C.," East of Little Cat Island; "Inlet," at the junction of Bay and the Lagoon exit; "Club," in the Bay, off the Hancock Club house; "BC," Big Cat Island. At Edge Cove, "Lab" means oysters growing near the Laboratory; "Mull," oysters from the mouth of the Mullica from planted beds, and transplanted to Edge Cove near the "Cynthia"; "GB," Great Bay plants; "Tank" refers to oysters both native and plants, kept in a tank into which the tides came twice daily. The capital letters indicate stations used in gathering the "fry" samples. "M" stands for Mullica; "Speck" indicates Great Bay oysters furnished by Captain James Speck.

In the column headed "Size No." the whole number of oysters opened is indicated classified into large, medium and small sizes, the latter one or two years old, the medium three or four years old, and the large ones more than four years old. The number of males and of females was determined of each class, and their condition as to progress of spawning noted. "Spw'd" indicates spawned out; "prt," partly spawned out; "mot," motile sperms; "nr" nearly ripe or nearly spawned; "pl" planted oysters.

Spawning Phenomena.

Studying the Barnegat record as to spawning, we find that about half of the oysters examined at the middle of June had begun spawning, and as half of the fry in the water were half grown at this time, it is evident that the best eggs had been ejected for some time. A surprisingly large proportion of oysters passed through the hot period of June 25th without spawning, probably because they were not mature and the period was too brief to complete the work. Usually the first week in July is extra hot, and had this been the case this year, these oysters would have spawned normally. Speaking in terms of the experience of the ancestors of these oysters, they were justified in waiting for this expected weather, but they were doomed to disappointment. The weather turned cold, the water became cooler and the ripening processes were repressed. The holding back of these eggs was injurious. They gradually decomposed, as shown by their granular appearance.

Towards the end of July we have indications of renewed spawning, and after August 2, it is hard to find oysters with sufficient spawn left for fertilization experiments. Evidently, the warm spell beginning July 19th and lasting to the 27th, enabled the oysters that had not spawned in June to complete this process.

Turning now to a consideration of the spawning data at Edge Cove, we find that oysters were nearly through spawning at June 28th, though there was little to show for it in the way of swimming fry. This refers

to the "natural" adult oysters of which there were fewer than usual, as most had been planted out in the Bay during the preceding Autumn. Perhaps this explains the general absence of fry at this time. The planted oysters, however, had not begun spawning, judging from a limited investigation early in July, but an examination of the plants July 18th, indicated that spawning had begun, and this tallies with the increased number of fry found. From this time, on well into August, it was increasingly easy to find oysters filled with ripe spawn. Naturals put into a special tank, became filled up again with spawn. The Great Bay plants transferred to Edge Cove near the laboratory, also became well filled. Oysters containing spawn, as well as those that had partly spawned, were easily obtained even during the period when the abundance of fry in the water showed that spawning was active. The plankton record of the latter part of August was proof that the oysters that held onto their eggs during early August, emitted them later. There was a peculiar continuity of spawning, new broods, small in number, being started every few days. There is reason to believe that these fry were weak and that very few came to the spatting stage. In fact, the conditions that favor a strong set of spat, are those that cause oysters to spawn *en masse,* quickly.

Table III—Spawning Data, Pertaining to Oyster Propagation, Barnegat, 1914.

Date.	Place.	Oysters.	Size No.	Males.	Condition.	Females.	Condition.	Miscellaneous.
June 15.	Anch.	Nat.	5 large.			5	Ripe.	
June 15.	Cox's.		11 small.	6.		5.		Half part spawned.
June 16.	Holl.		10 large.	5.		5.		Same.
June 16.			32 small.	21.		11.		Same.
June 17.	Cox's.		1 large.			1.	Part spawned	
June 17			6 small.	6	Poor.			
June 18.	A.		7 large.	1.	Ripe.	6.	Ripe.	
June 18.			17 small.	15.	Part spawned.	2	Part spawned.	
June 18.			7 clams.					Many ripe eggs and sperms.
June 20.	A.			4.	Ripe.			
June 22.	Holl.		6 large.	3.	Good.	3	Good.	
June 22.			37 small.	15.	Good.	22.	Good.	
June 24.	Holl.		14 large.	4.	Good.	10.	Good.	
June 24.			20 small.	11.	Good.	9.	Good.	
June 25.	Holl.		8 large.	3.		5.		Partly spawned; Fert. 11:45 a. m.
June 25.			36 small.	20.		16		Partly spawned; hatched 4:30 p. m.
July 2.	E. L. C.		7 large.	1.	Poor.	6.	2 good; 4 spawned.	E. L. C. East of Little Cat Island.
July 2.			20 small.	9.	6 good; 1 spawned.	11	3 good; 8 spawned.	
July 2.			16 clams.	6.	Ripe.	4	2 good.	2 with few eggs.
July 10.	E. L. C.		14 large.	8.	2 good.	6.	2 good.	
July 10.			10 small.	5	2 good.	5	3 good.	
July 11.	Holl.		3 large.	1.	Fair.	2.	Poor.	Eggs granular.
July 11.			10 small.	6	Good.	4.	2 good.	Eggs granular in 2.
July 13.	Holl.		10 large.	6.	2 good.	4	1 good.	Egg granular in 3.
July 13.			15 small.	9.	6 good.	6.	3 good.	Same; 1 large with Buceph.
July 14.	Holl.		4 large.	2.	1 good.	2.	Poor; part spawned.	
July 14.			9 small.	6.	2 good.	3.	1 good.	Most, near through spawning.
July 17.	Holl.	Natural.	4 large.	2.	Poor.	2.	Poor.	Eggs granular.
July 17.			18 small.	12.	7 good; 5 spawned.	6	4 good; 2 spawned.	Fert.; good result.
July 17.			1 med.	1.	Fine.			Cross of O and C gives no result.
July 17.		Clam.	1 clam.			1.	Ripe clam.	
July 20.	Bay.	Natural.	5 large.	2	Good.	3.	1 good.	Fert.; 10:20 a. m.; no result.
July 20.			9 small.	5.	Spawned.	4.	Spawned.	Toward Waretown, 8 ft. water.
July 20.	Inlet.	Natural.	4 med.	2.	Ripe and full.	2.	Ripe and full.	
July 22.	E. L. C.		15 large.	5.	Part spawned	10.	8 part; 2 spawned.	Eggs poor.
July 22.			13 small.	6	Spawned.	7.	4 part; 3 spawned.	Eggs good.
July 23.	Holl.	Natural.	7 large.	3	Spawned.	4.	Spawned.	1 large with Bucephalus.
July 23.			10 small.	4	1 good; 3 spawned.	6.	2 part good.	3 spawned; 1 not; but eggs poor.
July 23.		Clams.	4 med.	2.	Ripe.	2.	Fair.	Clam and oyster cross failed.
July 24.	Club.	Natural.	3 large.	1.	Spawned.	2.	1; few good.	

Table III—Spawning Data, Pertaining to Oyster Propagation, Barnegat, 1914—(Continued).

Date.	Place.	Oysters.	Size No.	Males.	Condition.	Females	Condition.	Miscellaneous.
July 24			3 small	1	Half spawned	2	Spawned	
July 24		Clam	1 clam	1	Few sperms			
July 27	Bay, bar	Natural	4 large	2	1 part spnd; 1 spnd	2	1 good; 1 poor	Sperms motile; fert. fair result.
July 29	Holl		4 large	2	Spawned	2	Poor	Fert. 10 a. m. with fair result.
July 29			10 small	6	3 fair; 3 spawned	4	Spawned	
Aug. 2	Club	Vir. H. I.	12 med.	4	Spawned	8	2 part spawned; good	6 spawned.
Aug. 2			5 small	2	Spawned	3	Spawned	
Aug. 3	B. C.	Natural	6 large	2	Spawned	4	Spawned	B. C. Big Cat Island.
Aug. 3			15 small	4	Spawned	11	Spawned	1 extra, with Buceph.
Aug. 6	Holl	Natural	1 large			1	Spawned	
Aug. 6			28 small	22	6 half; 16 spawned	6	Spawned	
Aug. 10	B.	Natural	2 large	1	Buceph.	1	Spawned	1 with Bucephalus.
Aug. 10			15 med.	7	Spawned	8	Spawned	
Aug. 10			8 small	6	Spawned	2	Spawned	
Aug. 12	Holl	Natural	Med.	8	2 good; 6 spawned	8	1 good; 7 spawned	
Aug. 12			Small	2	Spawned			
Aug. 15	E. L. C.	Natural	13 large	6	1 good; 5 spawned	7	2 part good; 5 spawned	
Aug. 15			10 med.	5	Spawned	5	Spawned	
Aug. 15			9 small	9	Spawned			1 with Bucephalus
Aug. 17	Holl	Natural	11 med.	8	2 part; 6 spawned	9	Spawned	Few granular eggs.
Aug. 17			2 small			2	Spawned	Few granular eggs.
Aug. 19	E. B. C.	Natural	12 large	4	1 part; 3 spawned	8	Spawned	Fattening.
Aug. 19			3 med.			3	Spawned	Fattening.
Aug. 19			13 small	7	Spawned	6	Spawned	Fattening.
Aug. 21	Holl	Natural	8 large	3	Spawned	5	Spawned	Fattening.
Aug. 21			8 med.	6	Spawned	2	Spawned	Fattening.
Aug. 21			6 small	2	Spawned	4	Spawned	Fattening.
Aug. 24	E. L. C.	Natural	7 large	3	Spawned	4	Spawned	Fattening.
Aug. 24			17 small	6	1 few sperms	11	Spawned	Fattening.
Aug. 26	Club	8 ft. water	10 large	6	Spawned	4	Spawned	Fattening ahead of Lagoon.
Aug. 26			9 med.	3	Spawned	6	Spawned	Fattening.
Aug. 26			9 small	7	Spawned	2	Spawned	Fattening.
Sept. 1	E. L. C.	Natural	6 large	4	1 mot. sperms	2	Spawned	Fattening.
Sept. 1			14 med.	6	2 mot. sperms	8	2; few good eggs	Fattening.
Sept. 1			29 small	18	Spawned	11	Spawned	Fattening.
Sept. 5	B.	Natural	4 large	3	1 mot. sperms	1	Spawned	Fattening.
Sept. 5			12 small	4	Spawned	8	2; few good eggs	Fattening.
Sept. 7	B.	Natural	9 large	6	2 mot. sperms	3	1 fof. eggs	
Sept. 7			13 small	4	Few sperms	9	Spawned	

Table IIIa—Spawning Data, Pertaining to Oyster Propagation Edge Cove, 1914.

Date.	Place.	Oysters.	Size No.	Males.	Condition.	Females.	Condition.	Miscellaneous
June 28	Ezra	Natural	13 small	6	Ripe	7	Part spawned	
July 2	Ezra	Natural	1 large			1	Part spawned	Most near through spawning
July 2			11 small	5	2 ripe; 3 not	6	Part spawned	
July 6	Lab.	Natural	5 large	1	1 not ripe	4	3 good; 1 poor	
July 7	Lab.	Natural	5 small	1	1 ripe	4	3 fair; 1 poor	
July 7	E.	Plants	21 med.	7	4 ripe; 3 poor	14	Good	Wormy shells.
July 18	E.	Plants	4 large		Spawned		Spawned	Wormy; spongy
July 18			10 med.		Spawned		Spawned	Traces of spawn.
July 21	Mull.	Plants	6 large	3	1 full; 2 part spawned	3	2 full, 1 granular.	
July 21	G. B.	Plants	6 large	1	1 part spawned	5	3 part; 2 spawned	
July 23	Lab.	M. Plants	6 large	1	Full	1	Full	4 spawned.
July 27	Tank	G. B. Pl.	12 med.	7	3 full; 2 nr. ripe	5	3 full; 1 near ripe, 1 sp	3 spawned.
July 27	Tank	Ezra Nat.	6 med.	2	2 full	3	Full	1 spawned
July 27	Lab.	G. B. Pl.	2 large	1	Full	1	Full	
July 27			8 med.	2	Full	5	2 full; 3 part spawned	1 Bucephalus.
July 27	Lab.	M. Plants	7 large	2	Ripening	5	3 full; 2 ripening	
July 27			3 med.	1	Part spawned	1	Part spawned	
July 30	Tank	G. B. M.	2 large	1	Near full	1	Full	
July 30			3 med.	3	2 near full; 1 spnd.			
July 30		Ezra	1 med.					Spawned
July 30	Lab.	Plants	6 large	2	2 full	2	1 full, 1 spawned.	2 fat.
July 30			8 med.	3	2 full; 1 spawned	2	1 half; 1 spawned.	3 fattening.
Aug. 8	Lab.	Plants	10 large	4	2 full; 2 half.	4	2 full; 2 half.	2 fattening.
Aug. 8			14 small	3	2 full; 1 half.	3	1 full; 2 half.	8 fattening, doubtful
Aug. 14	G. B.	Speck	24 med.	12	9 full; 3 spawned	12	Full	

§5 SPATTING DATA.

Explanatory of Tables IV and IVa.

In Tables IV and IVa there is exhibited the record of the observations on spatting for the season of 1914, respectively at Barnegat and at Tuckerton. The first column gives the dates when cultch was placed, the second, gives the dates when the same cultch was taken at the close of the experiment. The third column contains the designation of the stations at which these experimental exposures of cultch were made. At Station B, which is the same as B in Table II, the cultch was, with few exceptions, put in a floating crate, while at C, which corresponds to C of Table, II, the cultch was put on the bottom, that is, its position was "fixed." In the fourth column, the kind of a cultch is indicated whether "shells" (mainly oyster shells) or tiles, "T," (mainly flat tiles); curved tiles are called "cave" "T."

In the column headed "Conditions," the position and exposure of the cultch are described whether exposed all the time or only by daylight, or only during the night. The inner side of oyster shells being concave corresponds to the "cave" side of tiles. The outer side corresponds to the convex ("vex") side of tiles. Sometimes the concave side, sometimes the convex side was uppermost. In the column headed "Distribution, Nos. and Sizes," the number of spat caught is given with their position, whether on the upper or lower side, the outer or inner, etc. The size is given in millimeters, "mm." (A millimeter is the twenty-fifth part of an inch.) In the Miscellaneous Column, the principal information given is the probable date of the "setting."

Spatting Phenomena of 1914.

A glance at the tables, particularly that of Barnegat, shows that numerous experimental exposures of cultch were made. Experiments of this sort have given marked results in previous years; but during this past season, most of them proved negative. Even in the positive cases the number caught on each piece of cultch was so small that it became necessary to leave the cultch for one or even two months before the spat were easily discoverable. During this period there occurred from two to four special dates of spatting, so that we secured spat of corresponding sizes.

The spatting periods were not determined directly from the cultch experiments as in previous years, but rather were calculated from the plankton data. Under these circumstances it remains possible that the differences in size found do not, all of them, represent different spatting periods, but are due to differences in the rate of growth. The plankton data fixed the spatting dates at June 25th to the 29th, July 8th to the 27th, August 3rd to the 10th, and August 20th to the 28th. The largest proportion set in the second half of July. At Barnegat no spatting was observed after that period, nor at Tuckerton, earlier than that period. It is somewhat difficult to explain this, as the water was slightly warmer at Tuckerton. Judging from reports published early in Au-

gust, most places on the North Atlantic Coast followed the Tuckerton time in that the oyster propagation occurred unusually late.

Relative to Canada, the writer discovered by microscopic examination August 29th, the earliest spat set in Richmond Bay, Prince Edward Island, and placed the commencement of the spatting at August 27th. This was two or three weeks later than on previous years as reported hy Dr. Stafford. Thus there was a general delay in propagation for the North Atlantic border, most marked the farthest north; and such a general result could only be due to conditions that were general.

It is both interesting and important to trace these influences of the weather on oyster propagation. It seems likely that the matter is complicated to such an extent that the exact determination of the relations cannot quickly or easily he made. This is why the writer has supported the plan of the observation service, established for the Bureau of Shell Fisheries. For himself he prefers to take up some of the many other problems connected with oyster culture, among which may be mentioned the "pollution" problem, the "freshening" problem, the "food value" problem, growth and fattening, artificial breeding, etc. Then too every little while comes up the problem of excessive death rate among oysters of all ages from spat to adult stage, calling for special and urgent investigation. It was the unusual death rate of oysters in certain beds in Mobile Bay that called our chief assistant, T. C. Nelson, to the South. His report will appear in the Bulletin of the U. S. States Bureau of Fisheries.

Table IV—Spatting Data of Oyster Propagation, Barnegat, 1914.

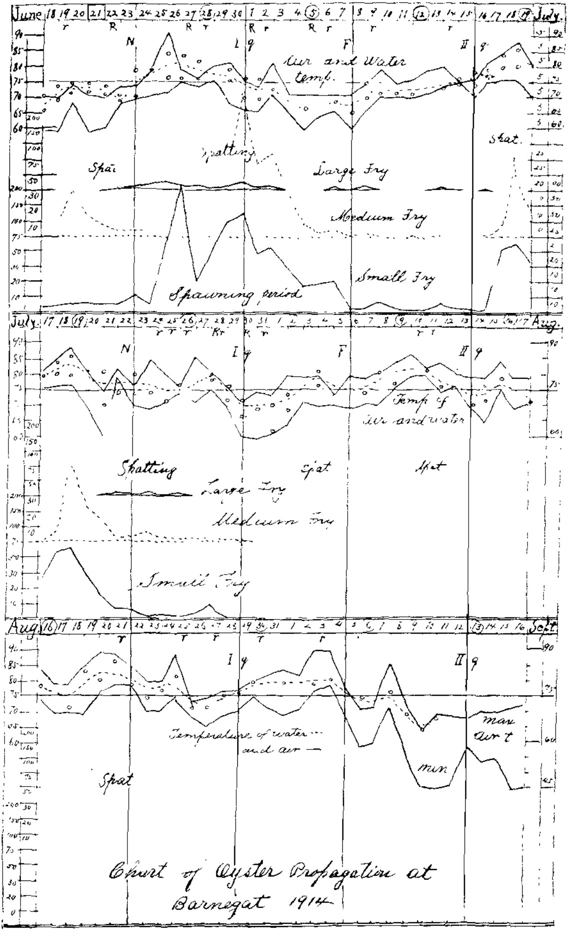
Date Planted.	Date Taken.	Place.	Cultch.	Conditions.	Distribution.	Nos.	Sizes.	Miscellaneous
June 29, 7 a. m.	June 30, 6 p. m.	B.	Tiles.	Floating, daytime.		0		Kept at T. gage at night.
June 29, 7 a. m.	June 30, 6 p. m.	C.	Flat T.	Bottom (fixt daytime.		0		
June 29, 6 p. m.	July 1, 7 a. m.	B.	Tiles.	Floating, night.		0		Kept at T. gage by *day*.
June 29, 6 p. m.	July 1, 7 a. m.	C.	Flat T.	Bottom, night.		0		
June 29, 6 p. m.	Aug. 26.	B.	Shell.			0		
June 29, 6 p. m.	Aug. 30.	C.	Shell.		Cave, top.	1	25 mm.	Set about July 20th.
June 30, 6 p. m.	Aug. 26.	B.	Shell.			0		
June 30, 6 p. m.	July 24.	C.	Shell.	Bottom.	Inner 2, outer 2.	4		Set about July 8th
July 1, 6 p. m.	Aug. 31.	B.	Shell.			0		
July 1, 6 p. m.	Aug. 31.	C.	Shell.	Bottom.	Lower 0, upper 3, 35,	28,	19 mm	Set July 8-17; 27; Aug 3
July 1, 6 p. m.	Aug. 31.	C.	Shell.		Lower, inner 2; upper 0;	26,	*18 mm*	Set July 27; Aug 3.
July 1 6 p. m.	July 8.	B.	Flat T.	Floating, night.		0		
July 1, 6 p. m.	July 8.	C.	Flat T.	Bottom, night.		0		
July 1, 6 p. m.	July 8.	B.	Flat T.	Days and nights.		0		
July 1, 6 p. m.	July 8.	C.	Flat T.	Days and nights.		0		
July 2, 7 a. m.	July 8.	B.	Tiles.	Floating days		0		
July 2, 7 a. m.	July 8.	C.	Flat T.	Bottom, days		0		
July 2, 6. p. m.	Aug. 31.	B.	Shell.	Inside up.		0		
July 2, 6. p. m.	Aug. 31.	C.	Shell.	Inside up.		0		
July 3, 7. a. m.	Sept. 1.	B.	Shell.	Inside up.		0		
July 3, 7 a. m.	Aug. 31.	C.	Shell.	Inside up.		0		
July 3,	July 8.	B.	Flat T.	Shaded, continued.		0		
July 3,	July 8.	B.	Flat T.	Exposed, continued.		0		
July 7, 6:30 a. m.	Sept. 1.	B.	Shells.	1 inside up; 1 inside down.		0		
July 7, 6:30 a. m.	Aug. 31.	C.	Shells	" " " "		0		
July 7, 6 p. m.	Aug. 31.	Lab.	Shells			0		
July 7, 6 p. m.	Sept. 1.	B.	Shells.	3 inside up; 3 inside down		0		
July 8, 6 a. m.	Sept. 10.	B.	N. shells.	" " " "	3 recovered.	0		N. new clam shells.
July 8.	Sept. 10.	B.	O. shells	" " " "	3 recovered.	0		O. exposed to air 2 weeks
July 8.	Sept. 10.	B.	E. shells.	" " " "	5 recovered.	0		E. exposed to air 3 years
July 8.	Sept. 10.	B.	M. shells	" " " "	3 recovered.	0		M raked out of mud bottom
July 8.	Aug. 31.	C.	N.	" " " "	4 recovered.	1		
July 8.	Aug. 31.	C.	O.	" " " "	5 recovered.	0		
July 8.	Aug. 31.	C.	E.	" " " "	4 recovered, 1 inside up.		19 mm	Set about Aug 3.
July 8.	Sept. 7.	C.	M.	" " " "	All recovered; 1 inside up.		17 mm.	Set about Aug 10.
July 8.	Aug. 29.	B.	Flat T.	Float, shaded glaze down.		0		
July 8.		B.	Flat T.	Float, exposed, glaze down		0		
July 8.		B.	Flat T.	Float, shaded glaze up.		0		
July 8.		B.	Flat T.	Float, exposed, glaze up		0		
July 8.	Aug. 30.	C.	Cav. T.	Fixt, exposed, cav. down		1	22 mm	Set about Aug 3.
July 8.		C.	Cav. T.	Fixt, exposed, cav. up.		0		
July 8.	Aug. 29.	B.	Cav. T.	Float, exposed, cav. down		0		

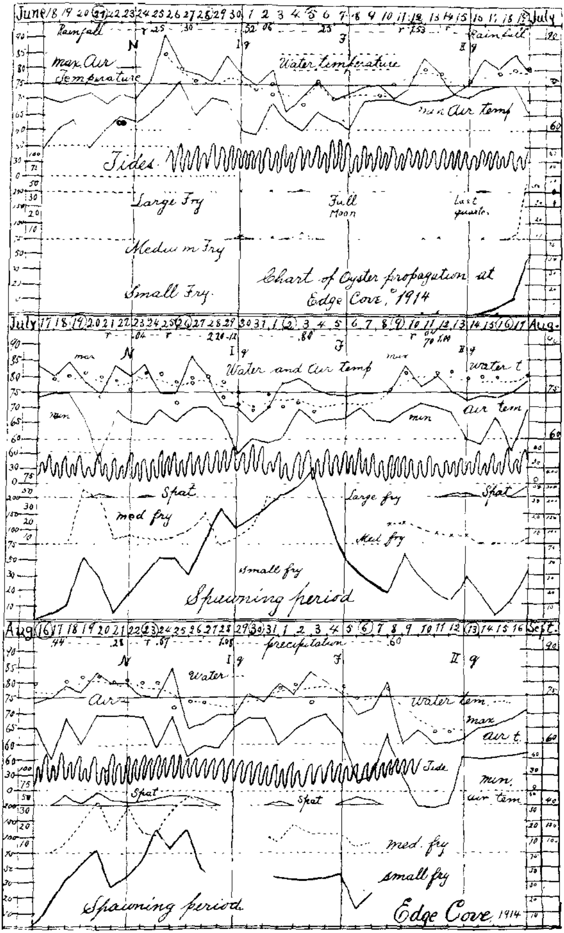
Table IV—Spatting Data of Oyster Propagation, Barnegat, 1914—(Continued).

Date Planted.	Date Taken.	Place.	Cultch.	Conditions.	Distribution.	Nos.	Sizes.	Miscellaneous
July 8		B.	Cav. T.	Float, exposed, cav. up		0		
July 8		B.	Flat T.	Float, exposed		0		
July 8		B.	Flat T.	Float, shade		0		
July 8	Sept. 1	B.	Shells	1 inside up; 1 inside down		0		
July 8	Aug. 31	C.	Shells	1 inside up; 1 inside down		0		
July 8	July 14	B.	Flat T.	Float, night		0		
July 8		B.	Flat T.	Float, day		0		
July 8		B.	Flat T.	Float, continual		0		
July 8		C.	Flat T.	Fixt, night		0		
July 8		C.	Flat T.	Fixt, day		0		
July 8		C.	Flat T.	Fixt, continual		0		
July 9	Sept. 1	B.	Shells	1 inside up; 1 inside down		0		
July 9	Aug. 31	C.	Shells	" " " "		1	28 mm	Set about July 27.
July 9	Aug. 31	B.	Shells	" " " "		0		
July 9	Aug. 31	C.	Shells	" " " "		0		
July 9	Sept. 9	C. I.	Shells	Heap on bottom	Cav. 24 mm.; vex. 13 mm.			Set about Aug. 3rd, 20th
July 9	Sept. 10	C. S.	Shells	" "	Vex. 21 mm			Set Aug. 10th
July 9	Sept. 9	B.	Shells	" "	Vex 27 mm.; 14 mm.; cav. 13 mm.			Set Aug. 3rd; 20th.
July 9	Sept. 9	C.	Shells	" "	Cav. 26 mm.; 16m; 14m.; 10 mm.			Set Aug. 3rd, 20th, 24th
July 9	Sept. 10	E. B. C.	Shells		Cav.	1	18 mm	Set about Aug. 10th.
July 13	Aug. 31	B.	Shells	1 inside up; 1 inside down		0		
July 13	Aug. 31	C.	Shells	" " " "		0		
July 14	Sept. 1	B.	Shells	" " " "		0		
July 14	Aug. 31	C.	Shells	" " " "		0		
July 14	Aug. 30	B.	Flat T.	Out continuously		0		
July 14		B.	Flat T.	Out nights		0		
July 14		B.	Flat T.	Out days		0		
July 14		C.	Flat T.	Out continuously		0		
July 14		C.	Flat T.	Out nights		0		
July 14		C.	Flat T.	Out days		0		
July 16	Sept. 1	B.	Shells	Bot., 1 ins. up; 1 ins. down		0		
July 16	Aug. 31	C.	Shells	" " " "		0		
July 17	Sept. 1	B.	Shells	" " " "	Vex. up	1	19 mm	Set Aug. 3rd, 10th
July 17	Aug. 31	C.	Shells	" " " "		0		
July 18	Sept. 1	B.	Shells	" " " "		0		
July 18	Aug. 31	C.	Shells	" " " "		0		
July 20	Sept. 1	B.	Shells	" " " "		0		
July 20	Aug. 31	C.	Shells	" " " "		0		
July 22	Sept. 1	B.	Shells	" " " "		0		
July 22	Aug. 31	C.	Shells	" " " "		0		
July 24	Sept. 1	B.	Shells	Inside up; inside down		0		
July 24	Aug. 31	C.	Shells	" " " "		0		

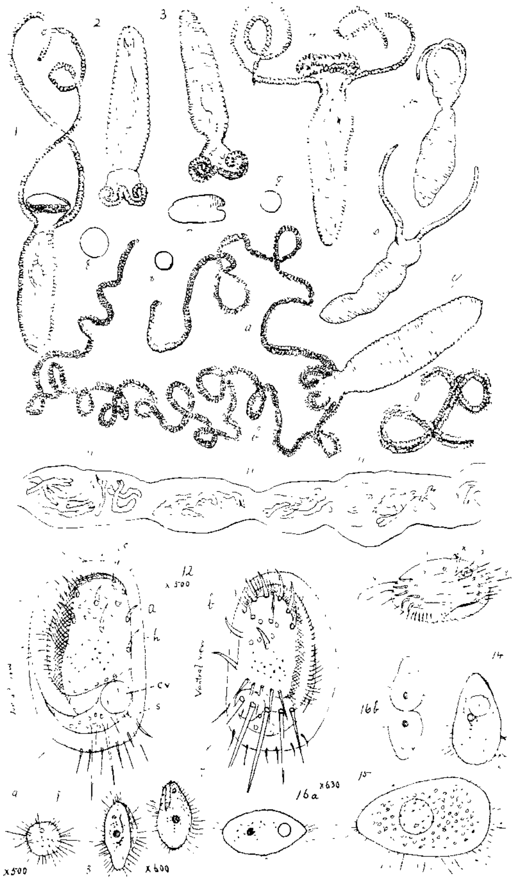
Table IV—Spatting Data of Oyster Propagation, Barnegat, 1914—(Continued).

Date Planted.	Date Taken.	Place.	Cultch.	Conditions	Distribution.	Nos	Sizes.	Miscellaneous.
July 25.		B.	Shells	Inside up; inside down.		0		
July 25.	Aug. 31.	C.	Shells	" " " "	Cave up	1	18 mm	Set about Aug. 3rd
July 26.	Sept. 1	B.	Shells	Inside up.		0		
July 26.	Aug. 31.	C.	Shells	Inside down.		0		
July 29.	Sept. 1	B.	Shells	Inside up.		0		
July 29.	Aug. 31.	C.	*Shell.*	Inside down.		0		
Aug. 1.	Sept. 9	B.	Shell			0		
Aug. 1.	Sept. 10	C.	Shell			0		
Aug. 3.	Sept. 9	B.	*Shell*			0		
Aug. 3.	Sept. 10	C.	Shell			0		
Aug. 5.	Sept. 9	B.	Shell			0		
Aug. 5.	Sept. 10.	C.	Shell			0		
Aug. 7.	Sept. 9.	B.	Shells	Fixed: inside up; ins down		0		
Aug. 7.	Aug. 31.	C	Shells	" " " "		0		
Aug. 10.	Sept. 9.	B.	Shells	" " " "		0		
Aug. 10.	Sept. 10	C.	*Shells*	" " " "		0		
Aug. 13	Sept. 9.	B	Shells	" " " "		0		
Aug. 13.	Sept. 10	C.	Shells	" " " "		0		
Aug. 15.	Sept. 9	B.	Shells	" " " "		0		
Aug. 15.	Sept. 10	C.	Shells	" " " "		0		
Aug. 17.	Sept. 9.	B.	Shells	" " " "		0		
Aug. 17.	Sept. 10.	C.	Shells	" " " "		0		
Aug. 20.	Sept. 9	B.	Shells	" " " "		0		
Aug. 20.	Sept. 10.	C.	Shells	" " " "		0		
Natural.	July 22.	Outlet.	O. shell.	26 shells	3 with; 4 spat.			
			C. shell.		1 with; 1 spat.			
Natural.	July 22.	E. C. I	O. shell.	24 shells	Cave, lower 3; vex. up 1 month			Set about *June 29th*
			C. shell	6 shells.	Vex. lower 2; cave up 2 month.			Set about June 29th.
Natural.	*July 23.*	*Club.*	*C. shell*	*6 shells.*	*Cave, lower 4; vex up 1 month*			*Set about June 29th.*
			O. shell.	16 shells.	Cave, lower 4; vex. *up 3 month*			Set about June 29th.
Natural.	Aug. 4.	C.	O. shell.		Cave, lower 1 6 weeks.			Set about June 24th.
	Aug 14	E. C. I.	O. shell.	18 shells.	6 spat, 21, 18, 17, 12, mm			Set about July 15th, 17th; 27th


June
July
Air and Water temp.
Spatting
Spat
Large Fry
Medium Fry
Small Fry
Spawning period
Aug.
Temp of air and water
Shatting
Sept.
Temperature of water ...
and air —
max air t
min
Chart of Oyster Propagation at Barnegat 1914



June
July
Aug.
Sept.
Rainfall
max Air Temperature
Water temperature
Tides
Large Fry
Medium Fry
Small Fry
Full Moon
Last quarter
Chart of Oyster propagation at Edge Cove, 1914
Water and Air temp
Spat
med fry
large fry
small fry
Spawning period
precipitation
Water
Air
max
min
air tem
med. fry
Edge Cove, 1914



Report of the Botanical Department.

BYRON D. HALSTED, SC. D.
B. H. A. GROTH, PH. D. EARLE J. OWEN, M. SC.
MARION T. PLEASANTS, A. B.* MATHILDE GROTH.

The research work for 1914 has been continued under the four projects approved two years ago namely: I. Heredity; II. Toxicology; III. Sap-circulation and IV. Environment.

For the study of Heredity fully 5,000 tomato and 3,000 pepper plants were grown in the breeding grounds and to these were added large numbers of crossed prairie berry plants, nine blocks of corn and several plots of beans, eggplants, soybeans, okra, etc. The season was not advantageous for large yields, but the protracted autumn drought and absence of early frosts permitted of an unusual amount of study in the field.

During the winter the greenhouse afforded an opportunity for the study of seedling growth of corn and soybeans, at different temperatures and depth of planting, under the project of environment and results indicated that some of the characters of the mature plant may be thus foretold.

Under sap-circulation it has been determined that the sweet potato plant when grown in a poisonous soil, inhibiting root storage, is able to deposit starch in the basal part of the stem.

EXPERIMENTS WITH CORN.

Nine blocks of corn were grown upon the four acres of experiment grounds, they being as far apart as possible and by taking note of the differences in time of bearing, very little mixing resulted. The blocks are reported upon below and in the order of their number in the field.

"Golden Queen" Upon "Brazilian Flour" F1.

This is a cross between a tall long-season variety of popcorn with the small slender yellow ears, frequently borne two or more to the stalk, and a stout, broad-leaved kind also late with large, stout ears usually produced singly with white grains that have a chalky endosperm. The block was somewhat uneven in season and size of plants, but finally produced a set of plants many of which were of unusual length with a range of over twelve feet down to five feet. The slender stalks, like the popcorn, bare the smaller ears with soft husks and the taller plants had the larger ears with thick closely adhering husks. Taking the block as a whole the "Golden Queen" seemed to be the most potent parent.

*Given leave of absence for a year to hold a fellowship in botany at Smith College.

In the present cross the evident great difference between the parents seems to have induced more or less sterility and consequent increased size of plants. *It follows from this that the cross in question could not be recommended as a good one for ears but might serve well for forage.* The characters of ears and grain may not be desirable. Intermediate ears between the two parents are long and slender with many rows of small flinty grains not husked with ease and possibly shelled witb difficulty. This cross was made for the purpose of the study of the influence of the *parents upon the size and type of stalk, ear and grains, also popability.* The ears and grains have not yet been measured or the grains tested for their ability to pop.

Plate I shows a series of ten crossed ears between sample ears* of the parents, the "Golden Queen" at 1 and "Brazilian Flour" at 12. The ears are arranged somewhat in the order of their agreement in size and grain conformation with their respective parents. There are no ears that might be mistaken for the popcorn but on the other hand a few ears appeared fully like the "Brazilian Flour" in size and shape of ear and grain but with the dominant yellow color excepted. It is remarked that the intermediate, those occupying the middle of the series are larger but not broader than either parent and attractive in every particular. *It is too soon to report upon the measurements of the ear and grains* as compared with those of the parents. This cross between a fine example of the flinty type of corn with one of a floury endosperm illustrates something of the inheritance of those widely different characters. While the plants grown were the direct result of the cross, their grains, because of Xenia, show the offspring inheritance in the second generation for endosperm and color characters. It is found that many of the grains have only chalky endosperm while upon the same ear, other grains are flinty. This is easily shown by cutting off the tips of the grains when the ears are freshly husked and before they have become dry. The floury grains can be easily cut upon an old ear and easily distinguished from flinty grains cut only with much difficulty. Upon many ears the floury grains are decidedly larger than their flinty associates. There is much influence exerted by the mother plant upon the degree of flouriness, some ears showing a large, others a small percentage of evidently floury grains. Taken as a whole, there is near a quarter of floury grains, thus suggesting that this character is a Mendelian recessive. The nearer the ear approaches the pop parent the less evident is the flouriness and it may nearly disappear. In this variability the character in question resembles that of sweetness in which case some ears of a commercial kind or a cross may be more starchy than others and is a plant character as shown by the fact that all the grains of the ear or ears of a stalk are nearly alike in this flintiness. In the "Brazilian Flour" itself some ears approach the flinty, while others have the grains truly floury and easily reduced to powder.

It is possible that in the present cross the floury grains not apparent to the eye may be segregated by the process of popping.

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*The photographs for the plates were taken by Prof. F. H. Dodge to whom many thanks are due for his skill.

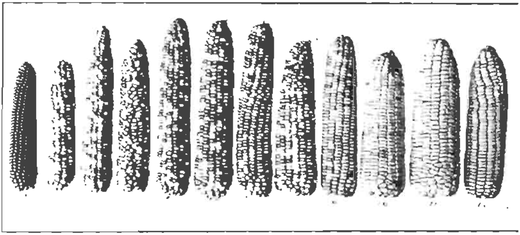

Plate I—*Crossed Corn:* "Golden Queen" upon "Brazilian Flour" (F_1) two quite opposite kinds in size of ear and texture of grain. The two parents are shown at the extreme right and left (1 and 12) with ten sample ears of the cross (F_1) between and arranged with regard to their likeness to the parents. Some ears (11) are extracted "Brazilian Flour" but none reproduce the "Golden Queen."

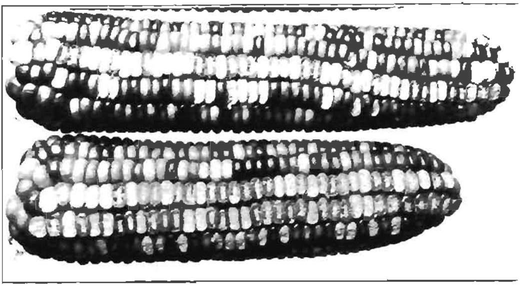

Plate II—*Crossed Corn:* Two ears of the "Golden Queen" upon "Brazilian Flour" with the upper rows of grains (F_2) cut, while still soft to show that certain kernels are starchy throughout like the "Brazilian Flour," while the great majority are corneous and therefore in texture approach the "Golden Queen."

Plate II shows two ears of the above cross in the F_2 for the grains; the one at the left has one row with the grains cut through the upper half and showing fourteen floury grains, that is, uniformly white while the others exhibit a more or less distint dark thick layer the horny endosperm. Upon either side some of the chalky grains were cut some weeks after the central row was treated. The ear upon the right has two rows with the grains decapitated, while they were soft and it shows the striking difference in texture as noted above. In the left ear only a few of the grains have been cut after they had become dry.

It seems to be generally true that the floury grains are larger than their flinty neighbors, but this remains to be demonstrated where the weight, volume and specific gravity of the two types of grains from various ears have been separately determined.

The sweet grains in a crossed ear of starchy and sugary parents, respectively, are of course much smaller than their starchy mates, but when tested for volume before drying has taken place they are larger—the inference is that the flinty grains begin a process of shriuking at an earlier date; so here the flinty contracts in the process of becoming flinty, while the floury type more nearly retains its original size.

"Black Pop" Upon "Squaw-Country Gentleman" F_1.

This is a cross of the "Black Pop," a short season almost dwarf variety bearing small ears of black grains with a white extracted strain of a recent combination of the "squaw," a large-eared, dark-bluish floury grained sort in combination with "Country Gentleman," a standard zigzag sweet variety. This cross brings together three types of plants and ears and grains, more than is advised as a general rule in breeding.

The block was a good one in all respects as to vigor, size and yield of ears, but there was much variability in season and size of plants, the height varying from four feet two inches to eight feet two inches and the shorter stalks matured their ears early. Of the latter there were 45, all quite uniform in size and approximating the "Black Pop" in smallness, but none of them were of the small dimensions of the pollen parent ears. There were 195 ears of larger size harvested a month later and of these 77 had smooth tips to their grains and 118 were more or less dented. There were 62 ears that resembled the "Squaw," in being large, long and the grain somewhat dented. Eight ears had the grain more or less zigzag, as in the "Country Gentleman," three of these being dented and five smooth and three were wedge-shaped ("hand") at the tip where the grains were arranged without order (zigzag).

Plate III shows a series of the ears with the "Black Pop" at 1; "Squaw" at 8, and "Country Gentleman" at 12, with sample ears between. It is seen that the small dimensions of the pollen parent ear was only approached in the smallest ear from the block and placed next to it in the engraving. There were, however, many of these small ears as before stated, making a group of one-sixth of the total number that might be classed by themselves in size of plant and time of maturity. The ears at 7 and 9 are close to the "Squaw" in general type, the latter making an ear with the dimensions of the "Country Gentleman."

There were but few ears that equaled in size that of the "Squaw" and none exceeded it. In this case there was no broad, short type combined with a long, slender one to provide the conditions for excessive length in the cross. This cross carries the factor for floury grains derived from the "Squaw" through its cross with the "Country Gentleman" and it finds expression in many of the ears chiefly of the larger size.

In this block it was a surprise to find ears that upon becoming dry had the grains lifted from the cob. In some instances the grains were separated from the whole side of the ear, while in other cases a single row had been crossed out. Plate IV may help to illustrate this point. At 1 the excluded grain came from one side of the ear, but not confined to a single row, giving an almost zigzag appearance to the grain of this side of the ear. This is a broad short ear and the grains correspondingly broad and the shrinkage of the cob has brought about a kind of self-shelling. The other ear is of a different type but the shrinkage has been proportionally as great and the resulted shelling more uniform and not taken place at either end of the ear. By removing the grains in a single row at time of harvest the space will practically close up in the process of drying. It is natural to think that the factor for size of cob acting somewhat independently of the one for size of grain may account for this combination that results in the shelling of the grains by a process of squeezing. The "Black Pop" has a small cob and the "Squaw" a large one. Another year may bring some reply to questions that arise concerning this misfit.

"Black Pop" Upon "Early Adams" F_1.

A small block of the above cross was grown the past season and produced a somewhat uneven lot of plants. Both parents are early sorts, with medium small plants and short ears, but otherwise widely different. The plants ranged in height from four feet four inches to six feet six inches. There were 130 ears harvested, of which seven were with dented grains like the "Adams"; short, broad ears, 28; slender, like "Black Pop," 11, and 84 intermediates.

The seed parent type was more nearly reached than that of the "Black Pop." As both parents were short eared, no excessive length might be expected, but the "Adams" is much broader than the "Black Pop" and possibly on this account ears were produced larger than the larger parent. The whole work of testing the grains of this cross for popability is still to be done, as well as the determination of specific gravity.

"Golden Queen" Upon "Hickory King" F_1.

This block was attacked by crows and only two-thirds of a stand resulted. The plants grew to large size, the range in height being from six feet two inches to eleven feet two inches and the ears were borne high (seven feet). Both parents are long season kinds and this cross was the last to be harvested (October 20th). The ears are husked with much difficulty because of the many coarse husks that project in a long point beyond the ear and this would be enough to condemn this kind for com-

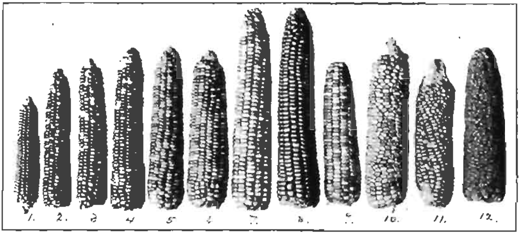

PLATE III—*Crossed Corn:* "Black Pop" upon "Squaw-Country Gentleman" (F_1). The three parents are shown at 1, 8, and 12, respectively, and the crossed ears are arranged between them. The "Squaw" is practically extracted at 7, neither the "Black Pop" nor "Country Gentleman" are very closely approached.

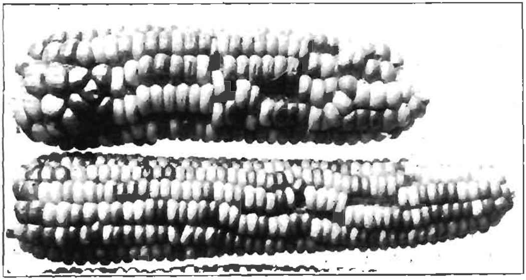

PLATE IV—*Crossed Corn:* Two ears of "Black Pop" upon "Squaw-Country Gentleman" (F_1) showing the effect of a misfit between the size of cob and the grains it bears. The grains have been squeezed out in drying thus bringing to notice a process of self-shelling that might be objectionable.

mercial purposes. Many of the ears are near the shape of the "Hickory King," but none would be mistaken for "Golden Queen." The dented grains prevail but in number of rows (10 to 14) the pop parent is generally followed. There were many twin ears and in one instance a fine triplet, a character for prolificness that came from the "Golden Queen."

It is too soon to report the measurements of ears and their grains and the degree of popability that each has inherited. On account of the prevalence of the dented grain it is not likely that a large-sized popcorn can be obtained here and, furthermore, the long season for growth and great size of plant would be objectionable. The number of ears was 156 and of these a large majority were nearer to the "Hickory King" than the "Golden Pop."

"Black Pop" Upon "Eight Rowed Pop Crosby" F_1.

In continuation of the study of the crossing of popcorns with other kinds a block was grown of the above combination. Previously a cross had been made of the "Eight-rowed Pop" upon an excellent but not yet popular sort, the "Crosby" sweet corn, the results of which have been given in the report of 1912. This cross was between a long, slender eight-rowed sort and a short-eared kind with more than eight rows of grains. The present combination has all of the parents short seasoned and this block was the first to be harvested fully matured (September 9th). The stalks were all short, four feet four inches to six feet eleven inches, chiefly near five feet. There were 185 eight-rowed, 19 ten-rowed and 5 twelve-rowed ears, thus showing that the potency of the "Eight-rowed Pop" was great against the "Crosby" and "Black Pop" with their usually greater number of rows to their ears. It is too soon to report upon the measurements of the ears and their grains and popability of the triple cross, and decide upon the type that may be superior to the early, small-eared "Black Pop," too unproductive for practical use, and the "Eight-rowed Pop" that is not popular.

"Golden Queen" Upon "Champion White Pearl" F_1.

This cross proved to be the best of the three blocks in which the "Golden Queen" was the pollen parent in uniformity, vigor and productiveness of the plants. In height the range was five feet nine inches to ten feet seven inches. As a rule the shorter plants were the most slender and produced the smallest ears, often two to a stalk and most nearly resembled the "Golden Queen." There were 374 good ears or a total of 14,960 per acre. Seventy were large like the "Champion," more or less dented and usually longer than this mother of the cross, while 25 only suggested strongly the "Golden Queen," but none of these had the size and shape of the pollen parent.

Plate V shows ten selected ears arranged between the two parents and according to their resemblance to them. The very handsome form of the ear of the "Golden Queen" (1) was most nearly approached in ears (4 and 5) but these were not the nearest in character of grain. On the other hand the "Champion" type was almost duplicated in a few instances

(11) and the majority of the ears were like those from 6 to 10—long and well filled with medium grains, more or less dented. It remains to be seen how well this crossed corn will pop and what is the average length and breadth of the cross as compared with those of the parents.

Flinty Sugary Cross—Reciprocals.

A block of a cross between "Gold Nugget" and "Black Mexican" was grown with reciprocals in alternate rows. The notes taken from time to time show that no differences were observed in size and vigor of plants, time of blooming, etc. The plants ranged from three feet ten inches to seven feet eleven inches. The "Gold Nugget" upon "Black Mexican" yielded 146 ears, of which 27 were ten-rowed and the reciprocal rows produced 153 ears, of which 36 were ten-rowed. Laid out in two parallel rows, the two lots closely resembled each other. The measurements of the ears and the grains may show differences not now apparent.

Breeder Plots of Corn.

There were two breeder plots for the purpose of furnishing new stocks for future trials of crosses. One of these was with white sweet corns and three kinds of popcorn, namely, "Eight-rowed Pop," "Golden Queen" and "Black Pop." In order to accommodate the long seasoned yellow pop it was planted three weeks before the various white sorts and for a similar reason the quick growing "Black Pop" was planted three weeks later than the general crop, thus making a difference of six weeks between the "Golden Queen" and the "Black Pop." With this difference in planting, a good supply of the cross between the yellow and the black pop sorts was secured. The thought is to grow these and note any difference between the reciprocals and at the same time determine the deviations from the parents and possibly secure a kind of corn that has a better season than either parent. Also it may be of interest to study the popability of a cross where both parents are popcorns.

A good supply of a cross between the "Eight-rowed Pop" and the yellow and black pop sorts and of all these popcorns upon the various sweet kinds was secured. For example, the plantings for three blocks has been secured from a single ear of the "Country Gentleman," that is, one parent will be in common for all the diverse progeny coming from these combinations. Some of the sweet kinds ("Crosby") bred best with the black, while others showed much more yellow, as "White Evergreen," "Stowells" and "Egyptian," but this may be due entirely to the harmony in blooming time.

A similar breeding plot was between the yellow and black pops and white kinds of flint, dent and floury corn. Crosses have been attained with a wide range of field corns that will help to establish the modifications that, for example, are produced by the "Golden Queen" with its small, hard grains upon such sorts as "Large White Flint," "North Dakota Flint," "Wisconsin White Dent," "Iowa Silver Mine," "Hickory King," "Tuscarora" and "Brazilian Flour." The two latter show at once in their grains the effect of crossing with a flinty corn. Instead of the soft, floury

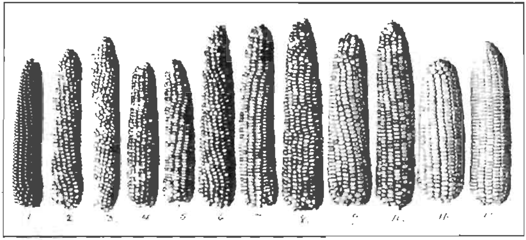

PLATE V—*Crossed Corn:* "Golden Queen" upon "Champion White Pearl" (F_1). A set of ten intermediate ears is shown from 2 to 11 and the parents at 1 and 12, respectively. The "Golden Queen" was not entirely reproduced, but there were a few ears of xtracted "Pearl." The several ear and grain characters are variously combined as instanced in the ear at 3, which is pop in size of ear and grain, but has many dented grains and at 6 is magnified pop, etc.

texture of the endosperm, it becomes horny for a large part of its contents. The size may change somewhat and the specific gravity, but these are details that need to be worked out from the stock on hand.

All of the various crosses above considered, whether between large and small-grained plants, indicate that the immediate change in the size of the grain is slight when the texture is the same. The size is a plant character and large xenic changes in texture arise only when the parents differ in the quality of endosperm and the grains are modified by shrinking, as in the striking instance of flinty and sugary grains upon the same ear.

Supplimental Plantings of Corn.

"Golden Bantam" and "New Tom Thumb." A cross was secured between the "Golden Bantam," a yellow, short season sweet corn and a white, rice, zigzag popcorn with short ears nearly as broad as long. As there was but a single stalk of the "Bantam," the sweet grains upon its ear are selfed. As both these crosses are short-seasoned and as the rule small in stature, the cross will admit of quick returns in the open or the greenhouse.

The cob of the popcorn is remarkable for its large girth as well as short length. It was noted that the tassels of the plants were peculiar in having the central stem—there were but few branches—of remarkable thickness corresponding to the extreme size of the cob. One is inclined to speculate as to this correlation, for both the sex organs primarily were in the same inflorescence and still are in fruitful suckers.

"Golden Queen Squaw" and "Squaw Golden Queen" F_1. In an out of the way place upon the College Farm the above reciprocals were grown, twelve alternating hills of each. Of the fruit, 13 ears were gathered all mixed yellow and black and a few white grains, indicating a hidden factor for the latter in the seed. The ears form a short series, from those quite like the "Golden Queen" to the "Squaw." All ears show chalky grains of the "Squaw" in such numbers as to suggest that this texture character is recessive. The reciprocal produced 13 ears also with none of them very close to "Golden Queen" or "Squaw" and they have much more of the blue or olive in the grain color than their mate. All the ears show the chalky texture excepting one ear, but in variable quantities and, of course, maybe of any of the many shades of color presented by this striking cross.

"Golden Queen"-"Chinese Waxy" and "Squaw"-"Chinese Waxy." Of the first cross three ears were obtained, intermediate in all respects between the parents. The texture of the grain is not yet studied. The second cross produced nine ears, all small as compared with "Squaw," long-pointed, with many rows (18) of small grains.

"Golden Tom Thumb," "Black Pop," "Earliest on Earth." These three dwarf or dwarfish kinds of corn, two pops and one sweet, were grown in the greenhouse and hand pollinated for the purpose of securing reciprocal crosses between the same pair of plants, namely, A upon B and B upon A, for each of the possible combinations of the three kinds. There is so much difference between the time of blooming of the pistils and stamens of the same plant that true reciprocals are not always possible and greater success attends the efforts with plants having more than one ear.

LIMITATION OF GRAINS UPON THE COB.

A study was begun of the possible effect upon future plants of the limitation of the grains in the ear. The thought being that an increased opportunity for enlargement with perhaps augmented food supply might lead to greater vigor in the plants that grow from such somewhat isolated grains upon the cob.

Various methods were tested but none in the open were easier than to leave the silk tips exposed for a day and then cover the ears with paper bags until the silk became dry. Repeated cutting off the silks as they grow out of the snipped end of the ear does not insure any great reduction of the grains. Partial hand pollination may prove as easy a way as any should this method of limitation warrant a general field practice.

Plate VI shows three pairs of ears, the one upon the left in each case illustrating the limitation. The first pair to the left is from the same stalk of a cross of the "Golden Queen" upon "Hickory King." The number of rows is not the same for the two ears, but in amount of dentedness the two should agree normally. The ear on which the grains have excess of space show the kernels to be often nearly spherical and the dents often lacking. The ears of the second pair are not from the same stalks of "Golden Queen-Brazillian Flour" but illustrate the form of grains produced when they are uninfluenced by their neighbors. They are like fine large pearls, when otherwise they might be flat and dented. This ear also represents the region of the cob that bears the ovules first pollinated. In the third pair of ears, a cross of "Golden Queen" upon "Champion White Pearl," the treated ear developed the grains more upon one side—the upper as a rule—than the other bent down fully before husking. Upon this ear one is able to compare the grains grown fully isolated with those closely compacted with their fellows.

It remains to be shown what the relative measurements of the two classes of grains bear to each other, their specific gravity and their comparative values as seed for a future crop. If there resulted a small gain in yield from this limitation of the number of grains to the ear it seems evident that the slight work necessary to secure the required seed would be profitable.

Viability Corns of Various Textures and Their Crosses.

In the following tables are presented some of the results of testing various kinds of corn for their power to germinate.

Table of Commercial Kinds of Corn.

Endosperm characteristic.	No. seeds planted.	No. of seedlings.	Percentage of viability.
Dents	1640	1458	88.9%
Pops	780	690	88.4%
Waxy	270	231	85.5%
Floury	1080	909	84.1%
Flinty	780	633	81.1%
Sugary	2610	1836	70.3%

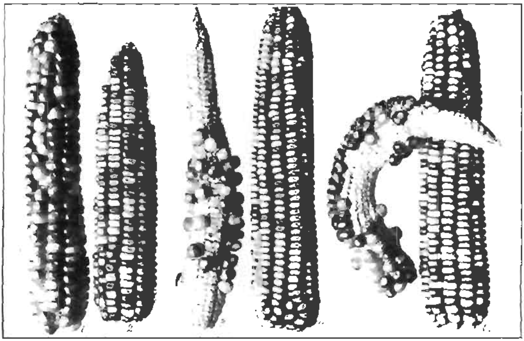

Plate VI—Crossed Corn: Pairs of ears from three different crosses showing the effect of forced limitation of grain production. The ears at 1 and 2 are from one stalk. The ear at 3 has but few grains, which are like pearls undented, while its mate has flat and dented kernels. At 5 is an ear that formed its grains chiefly upon the upper side, thus producing a bend.

The sugary makes a very distinct class by itself and may be compared with the starchy types as follows: Ground average for viability of all the kinds of grains with starchy endosperms, 85.6 per cent.; sugary, 70.3 per cent., or a difference of 15.3 per cent. in favor of the starchy types. The next table shows the results of tests of starchy and sugary corns taken from the same ear.

Table of Starchy and Sugary Grains from the same Eas F₂.

Endosperm characteristic.	STARCHY.			SUGARY		
	No of seeds.	No. of seedlings.	Percentage of viability.	No. of seeds.	No. of seedlings.	Average of viability
Pop-sugary. . . .	7340	7101	96.7	7340	6390	88 4
Flinty-sugary.	2680	2484	92.6	2680	1909	71 2
Floury-sugary.	2780	2273	81.7	2780	1726	62 0
Total and averages.	12800	11858	92 6	12800	10025	78 3

It is seen that from a total of 25,600 tested grains divided equally between the starchy and sugary type and from the same set of ears bearing the crossed grains in their second generation, the difference in viability was 14.3 per cent. The number of ears involved in this test were, of course, many, as only a comparatively few sweet grains were produced and in practically every instance the sugary fell below the starchy in power to germinate.

These results make it clear that sweet corn is a comparatively weak type. Experiments with the further growth of the seedlings show that the primary feebleness affects the whole life of the plant to some extent. Tests in sprouting the seeds under unfavorable conditions show that the starchy grains are much more superior to the sugary grains than the above results show. These tests were made under the best surroundings.

Variability in the Mesocotyl of Starchy and Sugary Corns.

The seedlings tested for viability were also measured and weighed to secure data upon variability and vigor. The portion selected for measurement was the mesocotyl, that is, the portion between the grain and the first leaf. Four crosses were involved in the tests, both starchy and sugary grains from the same sets of ears being planted in lots of 500 each, in greenhouse beds in three separate depths, namely, one, two, and three inches.

Table of Co-efficients of Variability for Crossed Corns.

Name of Cross	Texture of grain.	Depth planted.	Ave. length of mesocotyl.	Co-efficient of variability
"Eight-rowed Pop Crosby."	Starchy.	1 inch.	21.1	±16.8%
	Sugary.	1 inch.	21.1	±21 0%
	Starchy	2 inches.	48 9	± 8 7%
	Sugary.	2 inches.	50 0	±12.3%
	Starchy.	3 inches.	59.5	± 8.4%
	Sugary.	3 inches.	65.1	±10.4%
"Eight-rowed Pop Voorhees Red". . . .	Starchy.	1 inch.	36.3	±13.1%
	Sugary.	1 inch.	37.0	±150 %
	Starchy.	2 inches.	38 0	±17 8%
	Sugary.	2 inches.	46.5	±12.7%
	Starchy.	3 inches.	77 0	± 7.7%
	Sugary.	3 inches.	73 7	± 8 6%
"Gold Nugget Adams Crosby"	Starch.	1 inch.	25 7	±17.5%
	Sugary.	1 inch.	27.6	±20.3%
	Starch.	2 inches.	45 3	±10.9%
	Sugary.	2 inches.	44.3	±153 %
	Starchy.	3 inches.	73 8	±10.6%
	Sugary.	3 inshes.	73 5	±13 7%
"Voorhees Stowell-Golden Queen" .	Starchy.	1 inch.	28.4	±17.9%
	Sugary.	1 inch	33.3	±22.3%
	Starchy.	2 inches.	61 7	± 7 8%
	Sugary.	2 inches.	60 5	±12.0%
	Starchy.	3 inches.	68 8	± 8 3%
	Sugary.	3 inches	70.6	±10 8%

An average of all the co-efficients for the starchy is 12.04 per cent. and for the sugary, 14.53 per cent., a difference of 2.49 per cent., or in other words, the sweet grains are decidedly more variable in the length of the initial permanent upright structure of the young corn plant. Whether this greater variability is associated with a larger range of measurements of other plant structures remains to be shown and likewise more data are needed to establish a casual relation between variability and viability. It possibly may be shown that a lot of seeds with comparatively low viability will, therefore, produce seedlings of a corresponding greater variability.

When the variability of the mesocotyl is considered in connection with the depth of planting, the following set of averages is obtained.

One inch	Starchy	16.32%	Sugary. .	19.65%
Two inches	Starchy	11 30	Sugary. . .	13.07
Three inches	Starchy.	8 75	Sugary	10.87

In other words the variability is greatest when the grains are placed one inch below the surface of the soil and least (for this set) when three inches deep. It is possible that there is a more uniform environment for the growth of the mesocotyl in case of the greatest depth, as it is very true that this structure varies in average length directly with the depth of planting up to a certain limit of its possible elongation.

That one cross may be more variable than another is shown from the following statement of averages of deviation from the mean along with which is associated the averages of viability.

"Eight-rowed Pop-Crosby".	12.93%	97.17%
"Eight-rowed Pop Voorhees Red".	12.48%	90.48%
"Gold Nugget-Adams Crosby".	14.38%	84.23%
"Voorhees Stowell-Golden Queen"	13 18%	88 60%

The "Gold Nugget"-"Adams Crosby" is the most variable and the least viable and "Voorhees Stowell"-"Golden Queen" comes next in both respects. The two crosses with the "Eight-rowed Pop" are nearly the same in low variability, but differ in the viability, but both are high.

Influence of Limiting the Endosperm Upon Viability.

A large number of varieties and crosses were tested as to the removal of a portion of the grain (not cutting into the embryo) before planting. The grains were placed in warm water for several hours and a given number had nearly a half of the endosperm removed with a knife. These mutilated grains were planted in parallel rows with uncut similarly soaked seeds. The following table gives a condensed statement of the many trials.

Table of Influence of Limiting the Endosperm in Corn.

Kind and Condition of Seed.		No. of seedlings.	Viability.	Average days to emergence
Starchy	Cut	822	91.3	3.50
	Uncut	831	92.9	3.69
Sugary	Cut	151	62.9	4.05
	Uncut	196	81.6	3.88

The starchy grains do not show any marked reduction in viability, but it is striking with the sweet kernels. If the sweet grains are comparatively weak, this elimination heightens it. The time required to bring the tips of the corn plants to the surface of the soil (emergence) is not materially changed.

Popability in Corn—Preliminary Notes.

Popcorns have comparatively small grains and with a very high per cent. of corneous endosperm. In shape the grains range from those that are long and pointed (rice) to the broad smooth tipped sorts, as in the "Eight-rowed Pop"; the color may be white ("White Pearl"), yellow ("Golden Queen"), black ("Black Pop"), and all intermediate shades, as in the nondescript "mixed pops."

The popcorn plants are usually more slender than other kinds, but in season they show a remarkable range from the quick maturing "Tom Thumb" of low stature to others too slow for the New Jersey climate and producing very tall stalks.

There are many factors that enter into the study of popability, some within and others without the grain. For example, the moisture content is very influential and to equalize this, lots of grain were placed in a warm moist oven for several hours before testing for popability. Grains can be too dry as well as too moist for the best results.

Healthfulness, of course, modifies the results as, for example, mold and any mutilation should exclude a grain from the test as when marred in shelling or eaten even slightly by insects or mice. Tests with variously cut and filed grains show that any interference with the corneous envelope produces a weak place and prevents the full explosion caused by the heat.

Degree of Maturity Influences Popability. The degree of ripeness of the grains influences their explosiveness as shown in the table below. The "Golden Queen" is a long-season variety of popcorn that makes tall, slender stalks often bearing three, possibly more ears, thus making a series from the oldest to the youngest ear. Several stalks bearing three ears each

were cut at various stages of their ear development so that a wide range of maturity in the grains was obtained. One hundred grains were selected from each of a set of three ears from the same stalk and gave the following results:

	Fully Popped.	*Half Popped*	*Parched Only*
Oldest ear	80	12	8
Middle ear	50	18	32
Youngest ear	38	32	33

Five additional sets of three ears each, 100 grains for each popping, have their results given in percentage in the accompanying table.

	Weight of *100 grains.*	Volumn.	Specific *gravity.*	Fully *popped.*	Half *popped.*	Parched *only.*
Five oldest ears	9 52 gr.	7.25 cc	1.33	77.2%	13.2%	9 6%
Five middle ears	9.02 gr.	7.07 cc	1.28	68.8%	13 2%	18 0%
Five youngest ears.	7 88 gr.	6 25 cc	1.27	52.0%	19.6%	28.4%

The results show that the oldest ears gave a much larger per cent. of fully popped grains than the intermediate and least mature ears. In like manner the largest degree of popability is associated with the heaviest grains and greatest volume and specific gravity.

Shape of Grain Influences Popability.

A test for the influence of the shape of grain upon popability was made in connection with size and dentedness; the grains were selected from a cross of "Golden Queen" with "Voorhees-Stowell," the results being shown in the following table:

Character of Grain.	*Fully Popped.*	*Half Popped.*	*Parched Only.*
Large round dented		20	30
Small round dented	5	15	30
Large round undented	10	25	15
Large round dented		5	45
Small round dented		10	40
Large round undented		10	40
Small round undented	5	25	20

Listed with a single factor the results are:

	Fully Popped.	Half Popped.	Parched Only.
Large	10	60	130
Small	25	70	105
Round	30	80	90
Flat	5	50	145
Dented	5	50	145
Undented	30	80	90
Large flat dented	20	160	420
Small round undented	85	230	285
Large flat dented only		5	45
Small round, undented only	15	20	15

These tables show that the shape whether round, flat or dented, determines the popability in the cross much more than size. It is further noted that the factor for general shape and that for tip shape when all the grains are considered are of the same determining power.

Size of Grain Influences Popability.

A further study of the size of grain in connection with popability was made by selecting from crossbreeds fifteen of the largest and as many of the smallest grains from the same ear in thirteen instances. By combining the results the following statement is obtained: Fully popped—large grains, 0; small grains, 49; half popped—large grains, 40; small grains, 69; parched only—large grains, 155; small grains, 77.

While there is a great difference due to size, those results also show that crosses between pop and sweet corn, even when the grains are selected small, are not possessed with a high degree of popability. It is also possible that the smaller grains may be less mature than the larger ones, being taken from nearer the tip of the ear.

This subject of the influence of the position of the grains upon the ear is so closely related to position of seed in the pod that its treatment is placed elsewhere, it being shown that the grains just above the butt zone are (1) the first to form, (2) largest and (3) best for planting.

EXPERIMENTS WITH PEPPERS.

In the experiment with peppers a large fraction of the four acres of the breeding grounds was employed, the numbers of plants grown the past season being over 3,000.

The "Golden Queen-Red Cluster" Cross.

The chief line in hand is the study of the inheritance of the many characteristics of garden peppers and special prominence was given to the "Golden Queen"-"Red Cluster" cross in its second generation. In these parents many of the contrasting characters are exhibited. For example, the "Golden Queen" is a standard plant with the large, short petiole leaves borne singly; the fruit, as the name suggests is yellow pendant and is large, much ribbed, with depressed ends thickly walled, sweet and bearing large seeds. The "Red Cluster" is a dwarf with small, long-petioled leaves borne in clusters (fascicled). The fruit is red, upright, small, slender, smooth, pointed at both ends, thin-walled, hot and bearing small seeds.

First Generation of the Cross.

The cross of the large "Golden" upon the small "Red" is easily made and was grown last year in considerable numbers and some facts regarding it were reported for 1913. The plants were medium in stature with the foliage of the ordinary type and the fruits approaching in form those of the seed parent. *In length the fruit often exceeded that of either parent,* but the reader should remember that the larger parent has the tip extended inward so that the factor for length is not fully or normally expressed. In color the fruits were all red when fully mature, but a mixture with yellow was in evidence when the peppers were ripning. So far as was possible to test them these F_1 fruits were all pungent.

The reciprocal of the above cross, the "Red" upon the "Golden," is secured with difficulty and the plants are very different in many respects

and particularly in a lack of vigor. All these seedlings for 1913 perished either in the seed beds or shortly after the few that were alive went into the field. During the past season a few plants were grown. They showed remarkable variability, a few of them somewhat closely resembled their reciprocals, being medium low with normal branches, flowers and fruits, but nearly all were much taller with the leaves distinctly fascicled, profuse in large flowers, like the "Golden," stamens abortive and rarely any ripe fruits formed and these very small and nearly seedless. In short, the cross of the "Red" upon the "Golden" has produced only an occasional plant for the seeds obtained and then rarely grew into plants for setting in the field and those in turn proved almost barren. Seeds have been saved and attempts will be made to determine the relative fruitfulness of the offspring of those nearly barren plants. This has been a striking illustration of the remarkable difference that may exist between the reproductive factors of reciprocals, back of which lies the fundamental difference in glametic union. This is not the first time that this difference has been met with upon the breeding grounds, and the subject has become one for special study among various kinds of plants. When genetically widely separated plants are forced to breed sterility may result, but the present case is one of differing capacities between the sexes of two kinds that bred normally in one combination and far from it in the opposite.

The "Golden Queen" Upon "Red Clu ter" F_2.

There were 685 plants grown of this cross the present season but it is too soon to more than report a general outline of the results at this time.

1. *Standard and Dwarf.* The segregation of the plants into Dwarfs and Standards is not clean cut, nearly all the plants being intermediates. These were about 20 pure Dwarfs and 75 that might be styled Standards. The Dwarfs as a rule showed the fascicled foliage and bore but few fruits. There were all intergrades between these and the fully intermediates in size and fruitfulness.

Plate VII shows two plants photographed as they grew. (The whole area was set with two plants to a hill a foot apart, the hills being forty by forty inches each way.) The one upon the right is a semi-dwarf with fascicled foliage bringing the leaves compactly in a head. The fruits are likewise in groups and in this plant are pendent and quite obscured by the mass of long petioled leaves. Such plants have the internodes of the branches very short, thus making the whole top seem like a mass of foliage with the fruit underneath—a sort of chimney swab on a large scale. A plant of a quite opposite type is seen upon the left, in which the internodes are of ordinary length, leaves broad, short-petioled, fruit upright and with a large, loose, open top, this is a standard type of plant although it is one of medium height. Many were much taller, resembling the "Golden" parent.

2. *Single and Fascicled Foliage.* There were about eighty plants having plainly fascicled foliage. This character of clustered leaves and branches was expressed in all degrees of development and in the plant some portions were much more fascicled than others. The fact that the

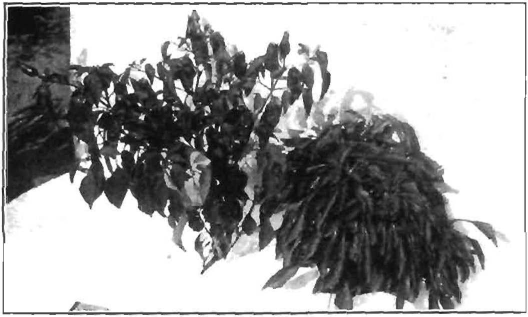

PLATE VII—*Crossed Peppers:* "Golden Queen" upon "Red Cluster" F_2. Two plants of this wide cross photographed as they grew and showing the marked differences of (1) size of plant, (2) arrangement of leaves, and (3) position of fruit.

length of internode is a varying character, bringing about all heights of plants with clustered leaves, some including tall specimens of fantastic form was well illustrated.

3. *Large and Small Leaves.* There seems to be all intermediates between the broad short-petioled leaves like the "Golden" and the narrow long-petioled type of the cluster parent. The long-petioled leaf is associated with the fascicled type of placement; occasion for this is apparent when one considers the primary function of the blade of an ordinary leaf.

Plate X gives a number of samples, a single leaf from a plant arranged in part in regard to the length of the petiole from the short to the long. Those in the upper left hand corner are most like the "Golden" and those at the opposite corner resemble the "Cluster" in length but not in breadth. The small leaves near the middle of the lower side are the nearest approach to the "Chester" for this parent is a very small-leaved variety of dwarf pepper. While the leaves upon any pepper plant vary more or less, it is evident that the engraving shows a very wide range of sizes and shapes that do not admit of being readily thrown into well-defined groups. The length and breadth of the leaves of each plant have been taken and from these measurements some facts of inheritance of size and form may be obtained.

4. *Color of Fruit.* About one-quarter of the plants bore yellow fruits, showing that the red is a true dominant. Among the yellow-fruited plants there were a few that were decidedly lemon-colored until they were nearly mature, indicating that the light yellow is a phase through which these fruits pass in becoming orange at full maturity. The large majority of the yellow showed the orange early in their development. Among the red-fruited plants there were some that did not show yellow in this early stage, while the majority passed through the orange phase, suggesting that the yellow in the heterozygote appears before the red and is afterward masked by it.

5. *Size and Shape of Fruit.* There are some apparent associations of color with plant, leaf or other fruit characters.

Plate VIII shows a fruit of the "Golden" parent (wrong end up) at 1 and of "Cluster" at 2 with a sample each from 12 F_1 plants at 3. The upper two full rows represent a sample each from 50 representative and red-fruited plants arranged with regard to resemblance to parent, those nearest to "Golden" being upon the left of the first row and those close to "Cluster" at the right end of the second row. Fifty yellow-fruited plants are represented in the lower two rows, the fruits being arranged as for the red associates above.

In the first place it is noted that neither parent is fully repeated in their F_2 crosses even when the number of individuals approach a thousand. The "Cluster" type comes nearest in all the parts of the fruit—length, breadth, peduncle, calyx cup, etc. On the other hand, the "Golden" fruits in all instances lack much in size when the shape corresponds, but some of the long fruits, as at the end of the first row, have the volume near to that of the large parent, but the shape is an intermediate.

Many of the fruits of this cross are much longer than either parent, a result from the interaction of length and breadth, factors that do not admit of easy reckoning because of the inturned tip of the "Golden," thus rendering them difficult to measure. When the restraint so-to-write is overcome, there may result a fruit of the extreme length of the one shown at the lower left hand corner, and there were many plants that gave similar long fruits.

This plate gives some idea of the diversity of the fruit at the stem end. The large majority are with a sloping shoulder and a calyx cup often of considerable length like the "Cluster" while a less number have a broad square shoulder with the peduncle and a flat calyx arising from a fruit cup. All intermediate shapes are met with here as with the free ends of the fruits. The thickness of the peduncle of the "Golden" is associated with the larger, broader fruits while the slender stem of the "Cluster" is usually present with the slender peppers, but there are striking exceptions, as in the third and fourth fruits in the left end of the first row.

6. *Position of Fruit on the Plant.* There are nearly one-quarter of the fruits borne upright, the same strictly pendent and fully a half that are claimed as intermediate, among which are all degrees of uprightness and pendency. The number of pendent fruits increase with the age of the fruits because a pepper that is lateral when partly grown may bend down apparently of its own weight when fully developed. This downward tendency is greatest in the large long fruits so that upon some plants one may meet all positions of the peppers. No correlations have been observed between the character for position and for any other of the pepper plant.

7. *Flavor of the Fruit.* The "Golden" is a sweet pepper and the "Chester," a very hot sort, so that this cross gave ample opportunity to test the pungency of their offspring. This work of testing is a serious one when the instances are far up in the hundreds. A sample pepper for each plant was employed excepting in case of doubt as to the flavor when more were used. A hundred or so of fruits were laid out upon a numbered paper "checker board" and the testing extended over several weeks for five different persons. The pepper was tested as to its wall and its placentae and the record made upon the square previously occupied by the pepper. A person having tested a hot fruit (in the usual way with the tongue) is not able to do justice to another for sometime, so that this testing was an aside with other work. The writer cannot vouch for the accuracy of the record for degrees of pungency, but in general and for the present purpose it is set down that about 25 were sweet throughout the whole fruit and this mildness was not strictly associated with any particular size or shape of fruit. About 400 had a sweet wall and pungent placentæ, while some were moderately hot in wall and placentæ and a hundred were very hot.

8. *Thickness of Fruit Wall.* The two parents differed greatly in the thickness of the fruit wall and it can only be stated now in a general way that the larger the fruit the thicker the wall. However, a study of the records may bring out details of this inheritance.

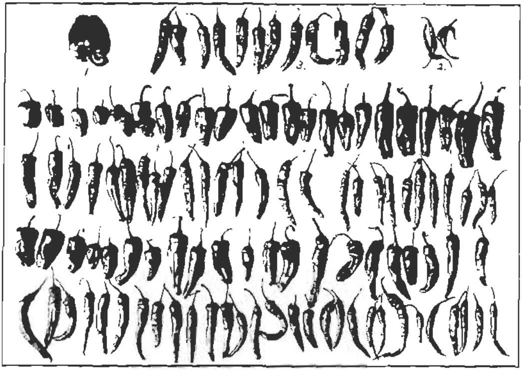

PLATE VIII—*Crossed Peppers:* "Golden Queen" upon "Red Cluster." A sample pepper from each of many red-fruited (F_2) plants is shown in the two upper full rows with the two parents represented at 1 and 2, respectively. A few sample fruits from (F_1) plants are shown at 2. The lower two rows are samples from yellow-fruited plants also arranged as to their resemblance to the parents.

9. *Seed Cavities of Fruit.* A record of this character was made for ten fruits from each plant. "Golden" has these locules usually 3 to 4 and the "Chester" quite uniformly 2. The cross yields fruits that are generally 2-loculed. Some with 3 and very few more than 3. There is a close correlation between size of fruit and number of locultes, that is, a long, slender plant is usually 2-celled and one that is broad 3-celled, possibly more.

10. *Size of Seeds.* The "Golden" has large and the "Cluster" comparatively small seeds. Seeds have been saved from one average fruit from each plant for study. In a general way it seems evident that there is a correlation between the size of fruit and that of its seeds, in other words, the smaller the fruit the smaller the seeds.

11. *Prolificness of the Plants.* Both parents in their way are prolific, for the "Golden" is a standard commercial kind with a few large fruits borne upon each plant, while the "Cluster" is a dwarf that for its size is prolific of small peppers. There was one very small plant that had only one fruit, about 30 plants had 10 or less peppers and a score or so bore as many as 150 mature fruits. In a block of plants where the size ranged from a few inches to three feet in height it might well be expected that the prolificness would also vary greatly.

Pepper Crosses in Their Third Generation.

Several crosses in their F_3 were grown, the total number of these plants being fully 2,000. Measurements were taken of the height and breadth of the plants, the length and width of ten average leaves and fruit of each plant, and the number of locules. One fruit from each plant was sketched in outline and cross section and its seeds saved. These records are being secured as this report goes to press and only general statements can be made at this early date.

"Golden Queen-Squash," F_3.

In the F_2 of the above cross (15/29) some plants had fruits nearly as long as the "Golden," others were of the solid flat type of the "Squash." The F_2 plants as a whole were medium low and broad-topped and the fruits abundant and of good market size with thick walls and sweet flavor. Plants were grown from ten different-sized fruits of the F_2 with a total of 65 plants that came into bearing. Of those, 51 were red-fruited and 14 bore yellow peppers. Three rows were all yellow and four were all red, while three had both red and yellow fruited plants, of which 19 were red and 5 yellow fruited, thus following the rule of segregating into the pure red and pure yellow (homozygote) and heterozygote for the two colors. In the matter of shape the separation is not as distinct as for color, but in a general way the 65 plants may be grouped as follows: approximating that of the "Queen," 14; "Squash," 40, and intermediate, 11. One fruit from each plant was sketched in outline and in cross-section and its seeds saved. It seems evident that one who is looking for the Mendelization connected with form might find it in the fruits of the cross under consideration.

"Golden Queen-Mexico A," F_3.

In this cross, of which there were nine rows grown from as many selfed mother fruits (F_2), several plants produced no fruits, and several with a few also grew to great size. The parental types were not adhered to and the fruits were intermediate, that is, not of the ratio of length to breadth of either the "Queen" or "Mexico A," but at the same time showed great uniformity in the row. Certain rows, for example, were of tall plants, while others were certainly much shorter, thus suggesting that plant-size was a matter of inheritance. Just how this subject of the size of plant will appear after the records are studied remains to be determined. Three of the rows had all red fruits and four all yellow, but two of these were of different fruits of the same mother plant. Only two had both red and yellow fruited plants.

"Procopp's Giant-Cherry," F_3.

This is the union of a large, very long fruited species with a small, round type, and in this generation among the seven rows there was not one that had all the plants with strictly "Cherry"-like fruits, while three rows had all the fruits long-pointed, however, of far less size than the "Procopp's." The upper part of Plate IX shows a sample fruit each from six of the rows. Another one of the most striking features is the general uniformity of the six groups (each representing an F_2 parent plant) with the exception of the four fruits at 2, which are not pointed and approach the "Cherry" type. Within each group there is much difference in length, but the well-developed point is generally present. It would seem to be difficult to secure a uniform race from this cross.

"Upright Sweet Salad-Cherry," F_3.

The "Salad" has a medium large broad fruit and the "Cherry" is much smaller and nearly spherical. In the F_2 among the many sizes and shapes none approximated either parent. In the F_3 there is no manifest separation into well-defined types. That a great number of sets of this cross might have added further information is evident from a study of the five sets of the "Salad," with "Floral Gem," the latter being practically a synonym for "Cherry." Two of these sets are uniformly of the general type shown in the engraving for the "Cherry" cross. Another set of ten fruits is uniformly wedge-shaped like the single fruit shown at the lower right hand corner, while one other set shows an extracted "Cherry" and a "Salad." This illustrates the supreme importance of large numbers from which to form opinions as to the possibilities in a cross like this.

"Ruby Giant-Cherry," F_3.

The "Ruby" has a medium long fruit with an enforced tip and is here bred with a small, smooth, spherical sort. The F_2 fruits showed two general types, a large round grooved "Cherry" and a long pointed "Ruby," with its size much below the "Ruby."

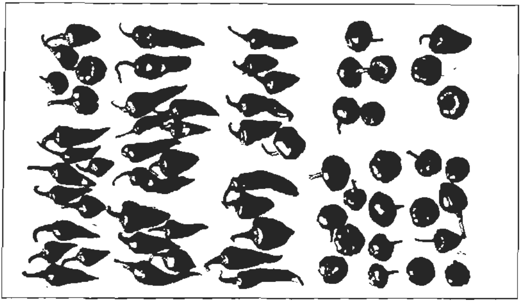

PLATE IX—*Crossed Peppers:* "Procropps Giant" upon "Cherry" F_2 (upper half). The groups of fruits from 1 to 6 are each from the same selfed mother fruit and show the dominance of the pointed type of fruit. The nearest to the "Cherry" as a whole set is at 2. "Upright-Sweet Salad" upon "Cherry" F_2 is shown in the lower four groups. As both parents differ chiefly in size there is no great range in dimensions or shape

Plate X shows samples—one for a plant of F_2 for this year grown along side of the F_3 for comparison. Among the 16 plants there was one with very long fruits and from this all graduations to the single small "Cherry"-like specimen were produced, the prevailing type being of good size, flat and more or less ribbed. The six groups making up the remaining portion of the plate are representative sample fruits of the F_3. The numbers associated with these groups are those of the F_2 mother plants and the measurements are known for all excepting No. 7. It is seen that in 7 and 13 the fruits are all long, those of 13 being more slender than those of 7 and is a repetition of the dimensions of the fruits of the parent plant. In 7 the "Ruby" is closely adhered to and unfortunately the record of the character of the fruit of the immediate parent (F_2) is not at hand. Numbers 14 and 20 are like the fruits of their respective immediate parents with somewhat of an increase of the ribbing in 14. Groups 11 and 12 are from fruits similar to 14 and 20, but here the factor for length is not excluded as shown by two fruits in each group. It would seem from a study of these that at least two types of fruit might be segregated that would become as uniform as the various commercial peppers. The No. 13 was a set of fine prolific plants with fruits in all respects desirable for trucking purposes. It may be further added that three rows, one each from three different mother fruits of No. 14 were grown, that is 14A, 14B, and 14C, and they were all of the same type, large, broad and among the finest fruits in the field. This was a test for modification that might be due to the environment of the fruit, but this and several other similar experiments show that the seeds of one fruit of a mother plant will probably produce the same general character of fruits as those of any other fruit, whether large or small, oval or pointed, or a mixed assortment of various sizes and shapes.

"Tomato-Cherry," F_3.

The shape of the fruit of these two kinds is nearly the same, the "Tomato" being much larger and is upright. The F_1 plant had their fruits pendent. The F_2 plants were 17 pendent, 7 upright and 6 intermediate. Among the F_3 plants, those from three fruits, were all pendent excepting one plant, one row had all upright fruits and of the two other rows one had the fruits all intermediate and the other had 4 plants, with upright and 5 with nearly pendent fruits. The classification might be into the upright and the pendent, the latter to include all that are not strictly upright.

"Magnum Dulce-Cherry," F_3.

In this cross extremes as to size are combined but in shape both are nearly spherical, the "Dulce" having a ribbed surface and incurved tip. In the F_1 plants none had fruits as large as "Dulce" or as small as "Cherry" and spherical type was departed from in a few cases, the fruits being wedge-shaped, that is, the factor for incurved tip having been overcome. The type of the parent is adhered to and furthermore there are two well-defined races met with in both the F_2 and F_3, namely a much

enlarged often somewhat ribbed "Cherry" and a long V-shaped, smooth fruit of desirable size that does not resemble either parent, but might be expected to breed true.

"Magnum Dulce-Mexico A," F_3.

In this cross as compared with the last the spherical "Cherry" is replaced by "Mexico A" with a small fruit that is twice as long as broad. The result of this stronger factor for length is strikingly shown. In this cross the "Dulce" is lost as to its large size and deep ribs, and only a suggestion of its inturned tip is met with as in No. 25.

"Squash-Bird's Eye," F_3.

The above cross is between a medium-sized coarse-leaved kind with flat thick-walled fruits and medium fine-leaved sort with small thin-walled fruits that fall easily from the plant when ripe. Eight F_2 fruits furnished plants for as many rows the past season. The eight plants in the first row were bushy and of the "Squash" type in foliage and fruit, row 2 was somewhat variable, but reproduced the "Bird's-Eye" closely, even to the crinkled leaves in some plants and the fruits were small, thin-walled, two out of the eight being deciduous. Row 3 of nine plants had all the plant and fruit characters of a "Squash" and the peppers persisted upon the stems. Rows 4 and 5 were nearly alike in their close resemblance to the "Bird's-Eye," excepting that in 4 the fruits were all persistent and in 5 all deciduous. Rows 6 and 7, ten and nine plants respectively, were mixed, some fine-leaved with small fruits, others coarse-leaved and "Squash"-like fruits. All fruits were persistent whether large and thick-walled or small. In row 8 the plants were low and the fruits generally of good size, the largest being deciduous.

"Anaheim Chili-Bird's Eye," F_3.

The "Anaheim" has a very long banana-shaped fruit with a stout persistent peduncle. In the F_1 the fruits were quite uniformly about twice as long as broad and deciduous. The F_2 fruits showed much difference in length, the breadth remaining quite constant and a half of the plants (20) had persistent fruits. There were types of plants as to size and the character of the foliage that must be considered later for the records of measurement.

"Bird's Eye-Cherry" and "Bird's Eye-Floral Gem," F_3.

The "Cherry" and "Floral Gem" are practically the same kind and the cross of the two with "Bird's Eye" are treated together. The F_1 fruits were intermediate, nearly heart-shaped and deciduous. Several of the F_2 plants produced elongated fruits like the "Bird's Eye" and in all 16 were deciduous and 18 persistent. Among the 17 sets of plants in F_3 there were only three entirely deciduous and five all persistent and among the mixed sets the number of the two types of stem was the same, namely, 33. There were a few other crosses with "Bird's Eye" made with particular regard to the deciduousness of the fruits, but it is too soon to report upon the records.

PLATE X—*Crossed Peppers:* "Ruby Giant" upon "Cherry" F_2 and F_3. At 1 are shown sample fruits from two lots of F_2 plants, among which the two parental types, that is, *the flat of the "Cherry" and long of the* "Giant" with some intergrades. The numbers below are of the F_2 selfed mother and it is evident that the two leading types of the F_2 are here breeding true, the "Giant" at 7 and 13 and the "Cherry" at 14 and 20, while 11 and 12 show a predomiannce of the "Cherry."

"Mexico A-Hot Sicilian F_3," Reciprocals.

This is a cross between two long pointed kinds and no variability in breadth was expected. As a matter of fact, the three generations are all generally alike excepting the length of the fruits. The "Mexico A" upon "Hot Sicilian" gives the larger range of fruits—the shortest and longest group and there is a wider "shoulder" and sharper point in the reciprocal, that is, "Hot Sicilian" upon "Mexico A"—and the measurements of plant and foliage may bring other differences to light.

"Cardinal Potherb-Cherry" and "Cardinal Potherb-Floral Gem," F_3.

The "Cardinal" is a variety with long, slender, often-curved and wrinkled fruits, and therefore the opposite of the "Cherry" and "Gem." In the F_1 the fruits are uniformly lance-shaped, nearly smooth, but in the F_2 there are shapes and sizes that range from one parent type to the other. There are too few plants in the whole series to warrant more than the opinion that there is hope of obtaining at least three widely different types of fruit, namely, the extracted parents and an intermediate and possibly for both thick and thin walls, thus making six races with distinctive points.

"Texas Shipper-Cherry," F_3.

This cross is between a broad, V-shaped smooth, thick-walled fruit and the familiar nearly spherical "Cherry," therefore size and shape are the chief points of difference. In F_1 the fruits were uniformly ovate and in the F_2 there were five fruits with pointed tips, three "Cherry"-like and sixteen of the size and shape of F_1, that is, ovate. Plate XI shows a sample of each parent at 1 and 2 respectively, and an average fruit from each of the F_1 plants at their right. The remaining portion of the plate is occupied with the representatives of the twenty-four F_2 plants. A study of these fruits in the two generations will lead to the opinion that the type of fruit represented by Nos. 3, 7 and 14 breeds true and is quite unlike either parent, behaving as a recessive as its relative number in the F_2 set suggests. On the other hand, the Nos. 6, 9 and 13 bred fairly close to the enlarged "Cherry," there being only two exceptions in the fifteen fruits of the three sets and those are merely a still more enlarged "Cherry." The remaining two groups of F_2 fruits (11 and 15) show the enlarged "Cherry" last mentioned in association with the new type with the pointed tip previously considered.

It seems possible that with sufficient instances it could be shown that the cross in question might produce three well-defined types, namely, (1) the enlarged "Cherry" as shown at 9 in both F_2 and F_3; (2) the blend type of the F_1 shown at 11 and 15 of F_2 and F_3 not isolated, and (3) the pointed type Nos. 3, 7 and 14 of the F_2 and F_3—a pepper of peculiar beauty and possible economic value.

"Glory-Cherry," F_3.

The "Glory" closely resembles the "Texas Shipper" type of pepper and gave similar results in all three generations when bred with the "Cherry," namely, the F_1 was a fairly uniform oval like the larger parent much reduced. The F_2 showed (1) the "Cherry" somewhat enlarged; (2) the oval of the blend (F_1), and (3) a slender V-shaped fruit that is the new type with the pointed tip. In the F_3 the (1) "Cherry" came nearly true in one set and appeared in all but three others; (2) the blend was pure in one set and was present in two others, while (3) the pointed tip fruits composed two sets and appeared in two others. After the three above types of fruit are removed there are very few intermediates in the F_3 set. It is evident that another year is needed to continue the isolation of the races. Through the third generation the number of well-defined types is three and neither parent is extracted, the nearest approach being with the "Cherry."

General Notes Upon the Third Generation.

It is too soon to draw conclusions concerning the potency of each factor in pepper breeding. Measurements of all the plants as to height and width have been taken and those may indicate the action of the factors for plant size and shape. The impression, as the plants are studied with note book in a more general way, is that with some crosses the inheritance of charters is continuous, while with others it appears discontinuous.

When one of the parents had fascicled foliage it appeared in a few of the F_3 offspring, but sometimes it was quite obscure. In some such plants it was present in parts of the plant only, that is, one large branch might bear clustered foliage, while other stems had the leaves single. In this connection it is added that barrenness was associated with the plants with fascicled leaves, and when possible seeds have been saved from partially barren and fascicled plants for further study.

The color of the fruit whether red or orange, the position of the fruit, that is, pendent or upright, and the attachment of the fruit whether deciduous or persistent, seem to conform to the Mendelian rule, that is, red, pendent and deciduous are dominant to orange, upright and persistent, respectively. Much larger numbers are desired for the last two pairs of characters for a full conviction as to the rule of inheritance in action.

Th foliage of peppers differs as greatly as the fruits. There are many sizes and shapes, from the small oval to the large lance-shaped, and some are smooth, others wrinkled (bullate) and occasionally curled along the margin; leaves may be dark or light green as a varietal character and whether this density of green is associated with thickness of leaf needs to be determined by many micro-measurements. Some kinds have very long petioles and as a rule this type is associated with the clustered method of arrangement upon the stem. As to this part of the subject it is written that measurements have been taken the past season of ten normal leaves as to length and breadth from each of thousands of plants and by means of these it is hoped to determine the average index, length divided

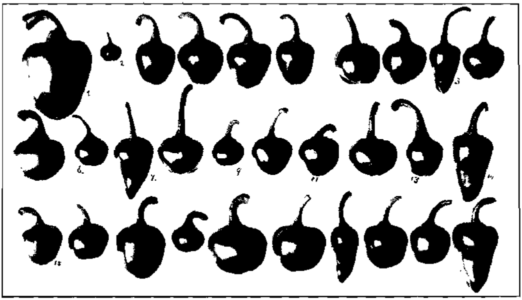

PLATE XI—*Crossed Peppers:* "Texas Shipper" upon "Cherry." At 1 is "Texas Shipper," 2 "Cherry" with four F_1 samples at their right followed with 24 samples of the F_2.

by the breadth, and find whether this is associated with the similar index of the fruit. In other words, is there any correlation between the size and form of leaf and that of the fruit of the same plant?

Within the same cross the dimensions of the fruit are frequently associated with the internal structure, thus a long lance-shaped pepper usually has but two seed cavities, while another fruit from the same plant may be much shorter and thicker and have three or more seed cavities. There is an evident casual relation between the high numbers of places for the seeds and the broader fruit. It is probably possible to predict the form of a fruit from the microscopic inspection of the ovary when the placentae, ovules and the places to bear them are already planned but still undeveloped.

The number of seeds to a fruit is a somewhat variable character and is not determined by actual size. Some of the largest commercial peppers have a low number of seeds and particularly the wrinkled sorts, the contortions seemingly depending largely upon the absence of seeds in certain parts of the placental region. There is an ornamental kind of pepper known as "Wrinkled" that has remarkably few seeds. Occasionally a small much contorted fruit is found on a normal plant and such fruit may be seedless and at the same time the wall of normal red (or yellow) color is highly pungent, thus showing that the flavor may develop in seedless fruits.

A STUDY OF THE INFLUENCE OF POD-POSITION UPON VIABILITY AND VIGOR OF SEEDLINGS.

Soybeans.

This work was begun in 1912 and some results were published in the report for last year. During the past winter and spring many tests were made in greenhouse and laboratory. The following table shows the results of a single 30-seed test, and the method employed in determining the rank for the different positions of the seeds in the pod:

Table for Soybeans—Position in the Pod Test—"Ito San."

Seed Position.	Viability.	Hypocotyl length.	First internode length.	Weight of seedling.	Total points.	Rank
1—seeded.......	100. (1)	122.1 cm (5)	82 4 cm. (5)	1 55 gr. (1)	12	2
2—seeded base...	93.3 (3)	125 6 cm. (2)	89.2 cm. (3)	1.39 gr. (5)	13	3
2—seeded tip...	100. (1)	123.3 cm. (4)	83 2 cm. (4)	1 41 gr. (4)	13	3
3—seeded base....	76.6 (4)	123 9 cm. (3)	79 7 cm. (6)	1.30 gr. (6)	19	4
3—seeded middle..	93.3 (3)	126 6 cm. (1)	90.2 cm. (1)	1 48 gr. (3)	8	1
3—seeded tip...	96 6 (2)	116 2 cm (6)	89 6 cm. (2)	1 51 gr. (2)	12	2

The figure in parenthesis is the rank, from 1 to 6 (highest to lowest) of the nnmber jnst preceding and the "total points" is the sums of the ranking figures for the four tests involved in the table. For example, the viability is highest for tips and lowest for base seeds. For an expression of vigor all the four ranking figures are added and from the last column thus obtained it is shown that the middle seeds of the 3-seeded pods are first in probable value for planting, and those at the tips of the same pods are next in importance, while the associated base seeds are of the least value.

A corresponding 30-seed set of "Wilson" soybeans tested at the same time as the "Ito San" shown above, gave the following results:

Table for Soybeans Position in the Pod Test—"Wilson."

Seed Position.	Viability.	Hypocotyl length.	First internode length.	Weight of seedlings.	Total points.
1—seeded	90 (3)-	147.1 cm. (3)	81.2 cm. (1)	1.11 gr. (4)	11
2—seeded base	100 (1)-	146.5 cm. 4)	74.1 cm. (5)	1.13 gr. (2)	12
2—seeded tip	93.3 (2)-	144.7 cm. (5)	78.6 cm. (2)	1.13 gr. (2)	11
3—seeded base	100 (1)-	141.3 cm. (6)	66.7 cm. (6)	1.06 gr. (5)	18
3—seeded middle	100 (1)-	148.3 cm. (2)	76.1 cm. (4)	1.18 gr. (1)	8
3—seeded tip	93.3 (2)-	186.7 cm. (1)	77.2 cm. (3)	1.12 gr. (3)	9

Here, as is the rule with this variety, the viability is very high, with the hypocotyl much longer, the first internode shorter, and the weight of seedlings heavier than in the "Ito San," illustrating verietal inherited characters. In total points it is seen that there is a general uniformity; thus the best seeds are in the middle position of the three-seeded pods and the poorest at the base of the same pods with the second best between the two. The above two tables are only sample results of many tests that below are brought together as to their rank for viability—vigor.

Table of Viability—Vigor Position in the Pod Test — "Ito San" and "Wilson."

ITO SAN.	Rank.	Wilson.	Average.
1—Seeded	4	6	5
2—Seeded base	3	5	4
2—Seeded tip	1	3	2
3—Seeded base	5	4	4 5
3—Seeded middle	3	1	2
3—Seeded tip	2	2	2

The tests embraced in the above table many thousand seeds and point to a decided difference in commercial value between the seeds in various positions in the pod. If an opinion is drawn from the average column the tip and middle seeds are all better than those from the base and single seeded pods. If one should make his selection among the pods only, the value of the 3-seeded is somewhat above the 2-seeded and both of these of course are far above the 1-seeded pods. Four-seeded pods are infrequently met with, but from a test of 285 such, it was shown that these seeds are of less value than those in average pods and their basal ones are the poorest of all and the ones next below the tip the best.

Pea Beans.

A little work upon the position in the pods with pea beans was reported last year involving only 420 pods with which it was shown that the 5-seeded pods gave the best results, of those the second and third seed from the base yielded the largest returns.

Table for Pea Beans, Position in the Pod Test—Six Seeded Pods.

No. of Test	I.	II.	III.	IV.	V.	VI.		
Where Made.	Electric bed.	Green-house.	Electric bed.	Electric bed.	Green-house.	Green-house.	Total points.	Rank.
Number of seeds	30	30	30	100	100	100		
Base	4	5	2	5	5	4	25	6
Second	3	4	3	2	4	2	18	4
Third	1	1	1	1	2	3	9	1
Fourth	1	3	2	4	6	1	17	3
Fifth	2	2	2	2	1	5	14	2
Tip	5	1	3	3	3	6	21	5

This condensed statement of the viability, hypocotyl and first internode length, and weight of seedlings for 2,340 seeds shows that for 6-seeded pods, the best seeds, that is, with greatest viability are borne third counting from the base and the next best are the fifth and fourth, while the least desirable are produced at the tip and base. The rank only for the seeds in all the sets of pods is given in the following table:

Table of Rank in Viability and Vigor of Seeds in 7, 6, 5, 4 and 3 Seeded Pods.

	7 Seeded.	6 Seeded.	5 Seeded.	4 Seeded.	3 Seeded.
Base	5	6	4	3	3
Second	6	4	3	1	2
Third	2	1	1	1	1
Fourth	1	3	2	2	..
Fifth	7	2	3		..
Sixth	3	5	.	.	..
Seventh	4	.			

It is shown that the best seeds are at the middle of the pods with the exception of those with three seeds, in which they are at the tip. Because 7-seeded pods were exceptional the number of those at hand were comparatively few, namely, 25, all other tests were with 95 pods.

I. When the pods are taken as the units the rank in value is: 1st, 3-seeded; 2nd, 4-seeded; 3d, 5-seeded; 4th, 6-seeded; and 5th, 7-seeded; that is, it may be a matter of practical importance to omit the pods that are excessively large when selecting the seed beans.

Cow Peas—"New Era."

The cow peas have long pods with many seeds (10-20) and the study here was with three lots of seeds made up of two basal, two middle and two tip seeds from each pod, and the results are given as follows:

Table for Cow Pea Position in the Pod Test.

Seed Position.	Viability.	Hypocotyl length.	First internode length.	Weight of seedlings.	Total points.	Rank.
Basal	83% (3)–	54.13 cm. (1)	20.38 cm. (2)	1.17 gr. (2)	8	2
Middle	97% (1)–	54.11 cm. (2)	20.23 cm. (1)	1.24 gr. (1)	5	1
Tip	91% (2)–	52.62 cm. (3)	20.38 cm. (3)	1.04 gr. (3)	10	3

The middle seeds are decidedly better than those from tip or base.

Another test was made in the same manner of (a) large-seeded pods, (b) medium-seeded pods, and (c) smaller-seeded pods, with the following results in ranking:

	Large-seeded.	Medium-seeded	Small-seeded.	Average.
Basal.	3	2	2	2 33
Middle.	1	1	1	1
Tip.	2	3	3	2 66

This shows a little superiority of the tip over the hasal seeds.

Corn.

A study of viability and vigor of corn in connection with the position of the grains upon the cob was made of nineteen ears, twenty sound grains being taken from (1) the base, (2) the third tenth zone from the base, and (3) the tip, the results of which are shown below.

Table for Position on the Cob Test of Corn.

	Viability.	Mesocotyl length.	Weight of seedlings.	Total points.	Rank.
Basal.	31 points.	36 points.	36 points.	103	2
Middle.	23 points.	36 points.	23 points.	82	1
Tip.	36 points.	41 points	53 points.	130	3

The mesocotyl length is a character that is not influenced greatly by the seed, but by environment, as light and moisture in germination, that is, a grain sends its plumule to the surface of the soil and, therefore, depth of planting is the chief modifying factor in the length of the mesocotyl. All the seeds in this test were planted at the same depth and under other like conditions. By omiting the mesocotyl the viability and vigor (the latter determined by weight of seedling) may be studied by themselves. From these it is seen that position on the cob has a marked influence, the middle grains having comparatively small number of pointa against them and these rank much in the lead of the basal seeds, as these in turn are superior to those borne at the tip.

Weight of Seeds as Related to Number of Seeds in Pod.

Some weights have been taken of seeds as regards their position in the pod as shown below:

Table of Weights of Seeds of Soybeans.

	"Early Brown"	"Wilson."	Ito San.	Total points.	Rank.
1—Seeded.	.210 (1)	141 (2)	.200 (1)	4	1
2—Seeded base.	177 (6)	.139 (4)	190 (2)	12	5
2—Seeded tip.	.199 (4)	.142 (1)	.190 (2)	7	2
3—Seeded base.	.188 (5)	.124 (6)	.167 (3)	15	6
3—Seeded middle.	.209 (2)	.140 (3)	.187 (3)	8	3
3—Seeded tip.	.201 (3)	.132 (5)	.187 (3)	11	4

These figures are derived from 1,750 seeds each, excepting for the 1-seeded lots when only 950 were used. It is noted that the 1-seeded was

heaviest, followed by the tip and middle lots, the basal seeds being the highest in weight.

Lima Beans.

Two varieties of lima beans had the weights for the position in the pods taken as follows:

	"Henderson."	"Jackson Wonder."	Total points.	Rank.
1—Seeded	.489 gr. (1)	.581 gr. (1)	2	1
2—Seeded base	.446 gr. (3)	.516 gr. (3)	6	3
2—Seed d tip	.466 gr. (2)	.565 gr. (2)	4	2
3—Seeded base	.375 gr. (6)	.415 gr. (6)	12	6
3—Seeded middle	.402 gr. (5)	.481 gr. (5)	10	5
3—Seeded tip	.425 gr. (4)	.517 gr. (4)	8	4

It is noted that both sets are alike in the distribution of relative weights. The 1-seeded is the heaviest, 2-seeded next, and 3-seeded lightest of all. The basal seeds are lighter than those elsewhere in the pod and in the 3-seeded pods the order for weights is regular from the lightest at the base to the heaviest for the tip seeds. If the beans for the 1-seeded pods are considered as tip seeds, as they well may be, it follows that the tip seeds are regularly the largest and furthermore that the smaller the number in the pod the larger the seeds. It is not yet known what relation seed weights may have to viability and vigor.

ABORTIVENESS OF OVULES IN CONNECTION WITH POSITION IN POD.

The viability and vigor of seeds and seedlings may bare some relation to abortiveness of ovules and a study has been made of this failure in the formation of seed. The pods were grouped according to the number of ovules.

Canada Peas.

Pods were gathered from a field of oats and peas upon the College Farm and after assortment as to the number of ovules the following results in terms of percentage of failures were obtained:

Table of Abortiveness in Canada Peas.

Character of pod.	No. of pods	Base.	2	3	4	5	6	7	Tip.
8—ovuled.	9	88.8%	77.7%	33.3%	00%	00 %	22.2%	55.5%	100%
7—ovuled.	102	70 5%	38.2%	8.8%	3.9%	7.8%	40.1%	84.3%	
6—ovuled.	160	48.1%	18.1%	6.8%	6.8%	20.6%	68.1%	......	......
5—ovuled.	89	38 2%	7.8%	56 %	12.3%	55.0%	......	......	......

The failures were always greater in the tip ovules and next in the basal ones; third, those next to the tip and fourth, the next above the basal ones. The lowest percentage of abortiveness was in the central region of the pod for all the kinds of pods. In other words the largest number of peas was produced in the middle of the pod. An inspection of young pods leads to the opinion that the middle ovules are the first to begin their development into seeds and by inference they were first to be fertilized.

A study of the table reveals further that the abortiveness is highest in the terminal ovules and that the percentages decrease in a regular order to the 5-seeded pods. The same is likewise true of the ovules next to the terminals and in the same manner with the third, thus leaving included the two of the 8-seeded pods without any abortions and the middle one in the 7-seeded row with the next smallest number of failures.

When this table is compared with the one of viability and vigor of seeds and seedlings, it is noted that there is a striking uniformity in the rank for the different positions in the pod. The following is a tabular statement for the 5 and 6 ovules and 5 and 6-seeded pods:

5-ovuled	4-3 -1-2 -3	6-ovuled	4-2-1-1-3 .5
5-seeded	4-2 -1-3 -5	6-seeded	6 4-1.3-2 -5
Average	4-2 5. 1-2.5-4	Average	5-3-1 2-2 5-5

It is only reasonable to associate the viability and vigor of seeds and seedlings of any position in the pod with the fecundity or seed producing capacity associated with those positions.

In other words the larger the percentage of abortive seeds in any position the less viable and vigorous the seeds and seedlings that arise from the same position in the pod.

Soybeans.

From the study of the abortiveness of seeds as related to position in the pod with soybeans the following table is constructed:

	"Early Brown."	"Wilson."	"Ito San."	Total
One-seeded Pods.				
1-ovuled only	446	51	308	805
2-ovuled basal ovule abortive	168	24	123	315
2-ovuled tip ovule abortive	62	12	45	119
3-ovuled basal and middle ovule abortive	34	8	37	79
3-ovuled basal and tip ovule abortive	8	5	11	24
3-ovule middle and tip ovule abortive	2	...	2	4
	720	100	526	1346
Two-seeded Pods.				
2-ovuled only	682	354	445	1481
3-ovuled basal ovule abortive	234	44	113	391
3-ovuled middle ovule abortive	75	16	36	127
3-ovuled tip ovule abortive	17	11	22	50
4-ovuled basal and 2nd ovule abortive	1	....	.	1
4-ovuled basal and 3rd ovule abortive	2	....	...	2
	1011	425	616	2052
Three-seeded Pods.				
3-ovuled only	347	300	300	947
4-ovuled basal ovule abortive	6	1	2	9
4-ovuled next to basal abortive	5	....	...	5
4-ovuled next to tip abortive	23	....	.	23
	381	301	302	984

This table shows that the great preponderance of abortiveness is in the basal ovules, thus among the two-ovuled pods it is 315 to 119 for the tip and among the three-ovuled pods it is 391 to 50 for the tip. Two ovules in the middle region rank between the basal and tip in abortiveness.

It still remains to determine the value in terms of viability and vigor of these seeds borne thus in such somewhat different surroundings.

Lima Beans.

Only two varieties of the lima beans were studied as to abortiveness of the ovules and the results are given below:

	"Henderson."	"Jackson Wonder."	Total
One-Seeded Pods:			
1–ovuled only	24	16	40
2–ovuled–basal ovule abortive	5	16	21
2–ovuled tip ovule abortive		2	2
3–ovuled basal and middle ovule abortive	13	3	16
3–ovuled middle and tip ovule abortive	1		1
	43	37	80
Two-seeded pods:			
2–ovuled only	48	65	113
3–ovuled basal ovule abortive	56	42	98
3–ovuled tip ovule abortive	..	2	2
3–ovuled middle ovule abortive	16	10	26
4–ovuled base and tip, ovule abortive	...	2	2
	120	121	241

As in the soybeans it is seen that the abortiveness is chiefly in the basal ovules, namely, 137 instances as compared with 5 for the tip.

Wistaria.

The Wistaria (*Wistaria Chinensis, DC.*) was unusually fruitful the present season and it was convenient to secure a supply of its large pods. These pods are nearly always with six ovules, those with five and seven being met with rarely. One hundred of the ripe pods were opened and the seeds and abortive ovules recorded for each position in each pod. The following table gives the number of seeds for each position and the average weight of the seed for each set:

Table of Position in the Pod—Test for Wistaria.

	Number of seed.	Weight of single seed.	Rank.
Basal	24 (6)	.37 (5)	5 5
Second	45 (5)	.37 (5)	5
Third	56 (4)	.40 (3)	3 5
Fourth	62 (1)	.41 (1)	1
Fifth	61 (2)	.42 (2)	2
Tip	59 (3)	36 (4)	3 5

It is noted that with this plant the abortiveness is greatest in the basal end and that the tip is low, the middle showing a comparatively high per cent. of seeds. In this test the rank for numbers corresponds closely with that for weight, that is, the largest seeds are produced in greatest numbers, and in the middle of the pod.

Abortiveness Associated With Position Upon the Plant.

Ten plants of "Ito San" soybeans from a field sown late for a green cover, and, owing to the prolonged drought had made but a small growth, were examined (1) as to number of pods in the (a) lower, (b) middle,

and (c) the top third, and from these three sets of pods the number of abortions were determined for the one, two and three-seeded pods.

Part of Plant.	One-ovuled.	Two-ovuled.	Three-ovuled.	Total.	Abortive ovules.
Basal..........	4	20	34	58	22
Middle..........	3	14	48	55	31
Top..........	10	17	39	66	52

It is seen that the abortive ovules increased from the lower to the upper third of the plant. The one-ovuled pods were more numerous at the top and the three-ovuled lead in numbers in the middle third of the plant.

Scarlet Runner.

The "Scarlet Runner" bean has very large seeds and lends itself well to the present study. From the several vines grown for breeding purposes the following series was gathered:

Table of Position in the Pod—Test for Scarlet Runner.

Character of Pods.	Number of pods.	Weight of single seed.	Character of Pod.	Number of pods.	Weight of single seed
1-seeded........	9	1.20 gr.	4-seeded third....	22	1.24 gr.
2-seeded base....	29	1.07 gr.	4-seeded tip.....	22	1.19 gr.
2-seeded tip......	29	1.11 gr.	5-seeded base....	2	1.10 gr.
3-seeded base.....	37	1.07 gr.	5-seeded second...	2	1.50 gr.
3-seeded middle...	37	1.17 gr.	5-seeded third....	2	1.55 gr.
3-seeded tip......	37	1.19 gr.	5-seeded fourth...	2	1.90 gr.
4-seeded base.....	22	1.07 gr.	5-seeded tip......	2	1.80 gr.
4-seeded second...	22	1.24 gr.			

The basal seeds are all lighter than those from any other position and the tip seeds are usually lighter than the middle ones. The heaviest seeds were produced in the 5-seeded pods and next in the 4-seeded. The percentage of abortiveness for the several sets of pods was omitted.

General Remarks Upon Abortiveness and Vigor.

While the instances are too few to warrant any conclusion it is quite possible that there is direct connection between the percentage of abortiveness and the vigor of plants produced from seeds borne in similar positions in the pod. For example, if a certain region of a pod produces but few seeds one may be suspicious of the high value of seeds that are there matured.

The examination of Canada peas showed that the greatest percentage of abortive ovules was at the extremities of the pods with greatest number of ovules, and the least abortiveness found at the middle of 5-seeded pods.

A much larger inspection of soybeans (4,382 instances) showed that the great preponderance of abortions was at the basal end, the least being at the tip. The same was found to be true with the lima beans and for wistaria.

Radish pods show a similar distribution of failures for the ovules and size of seeds, but the records are not ready for inclusion here.

If it be true that association with abortive ovules is an evidence of weakness it will be of service to the grower in many cases and lay stress upon the importance of selecting not only large seed, but from that region of fruits where abortions are least frequent.

It is possible that a trucker may find it to his advantage to select, for example, his Hubbard squash seed from a fruit with many seeds instead of from one in which the ovules were generally abortive, or tomato seeds of any given kind from fruits with many instead of few seeds. As an instance several strains of tomatoes have been produced upon our breeding grounds that are remarkable for few seeds and they are likewise "shy bearers." Back of both low seed-capacity and low fruitfulness may lie the factor for both these characters.

The Relation of Prolificness to Heredity.

A new phase of heredity has been begun concerning the relation to the appearance of infertile plants and their consequence among the normal specimens. It is no new event for barren plants to be present in almost any crop. They may be found among the particularly small (dwarfish) plants and as frequently they are the largest specimens in the field. Quite often they appear in the breeding blocks and of these the work will be concerned for a time at least.

It seems evident that sterility is associated generally with a wideness of the cross. While as a rule plants do not breed except within a very narrow range, yet there seems to be a fringe to this line of limitation in which union may sometimes take place, followed by offspring that are frequently of low seed production if not entirely barren. Some years ago a hybrid was secured between two species of egg-plants, the "American" (*Solanum Melongena*) and the "Chinese" (*S. integrifolium*). This union was secured after very many trials and the seeds in each fruit were few. The F_1 plants exhibited all degrees of vitality and ranged from dwarfs to giants, the latter flowering profusely but rarely produced fruits with viable seeds. In a similar manner the hybrid seeds produced between *Cucurbita pepo L* and *C. Maxinia duche* or *C. Moschala duche* are secured with difficulty and the plants from them yield sterile fruits. Some years ago a cross of a standard and dwarf tomato yielded a plant that was very different from its mates in being unusually large and the few fruits it produced were both small and nearly seedless. These exceptional characters have remained with the offspring for several generations and all of the many attempts to cross this strain with other tomatoes have failed.

Within the same species of the common pepper *(Capsicum annuum L.)* there is a great difference in the ease of successful union of the varieties and up to the present time repeated attempts have failed between some sorts that are widely different. In other words, some kinds of peppers breed freely while others do so if at all at rare intervals. Furthermore it

has been noted that the offspring of the easily secured crosses are as a rule more prolific than either parent for the first generation at least, while those crosses obtained by prolonged effort are more or less barren.

The hybrid between the "Scarlet Runner" (*Phaseolus multiflorus willd*) and bush bean (*P. vulgaris, l.*) is a subject that has been studied for several years and mentioned in previous annual reports. This spring a block was planted with F_3 seeds from (1) very prolific plants, and (2) those nearly barren in alternate rows, beginning with those of widest range of prolificness with results as shown below:

Row Number.	Pods of parent.	Pods of offspring average	Row Number.	Pods of parent.	Pods of offspring. Average.
1.	148	8.3	9	256	57 2
2.	10	....	10.	19	103 3
3.	472	96 2	11	233	16.3
4.	7	48.	12.	61	72.6
5.	98	275	13	123	164.
6.	17	7 5	14	103	72.4
7.	286	29.1	15	178	79.3
8.	10	32 6	16	79	56.5

In general the more prolific parent had offspring with greater seeding capacity, but there are striking exceptions. Again it has been demonstrated that the direction of the cross makes much difference as to the degree of ease with which the unions are obtained. For example, it is easier to breed a large fruited standard sort upon a small fruited sort than contrariwise, and the difference obtains with fruit production of the offspring. As an instance the case of the "Golden Queen" and "Red Cluster" is cited. The "Queen" upon the "Cluster" is an easy cross that yields fruitful progeny but the "Cluster" is crossed upon the "Queen" with difficulty and the seeds are feeble and only an occasional seedling will reach full size and while flowering abundantly rarely produces any fruit.

Such observations as the above has led to a study of the possible inheritance of a high or a low and likewise of any intermediate degree of fruitfulness among the individuals of any population of plants that have come from the same parents (pure line). Selfed plants are the ones that lend themselves most naturally to this work and as a consequence several selections were made last year for this purpose. Thus, from various plants-to-the-row tests samples of mature plants were selected upon the basis of relative prolificness, that is, seeds were saved separately from the plants with (1) the largest, and (2) the smallest number of seeds. To this character of seed-production was coupled the one of season so that there were four groups of seeds from each row. The subjects selected were (1) "Ito San" and (2) "Wilson" soybeans (the latter from a number of isolated races), (3) pea beans and (4) "New Era" cowpeas. A row each (near 25 plants) of these several tests have been harvested, but as yet there are no completed records ready for this report.

It goes without writing that there is a great range in the productiveness of plants from the same parents and it may be possible some day

to show whether this character is passed on to the offspring or is entirely a result of the play of environmental factors.

Relative Number of Seeds in Pods.

This study has been made in considerable numbers for only one subject, namely, "Early Brown" soybeans and it was found to be as follows: 1-seeded, 12.5 per cent.; 2-seeded, 49.2 per cent.; 3-seeded, 37.2 per cent.; 4-seeded, 1.1 per cent.

If the 4-seeded group is disregarded the ratios of the bulk of the pods is 2-*seeded*, 4; 3-*seeded*. 3; 1-*seeded*, 1; *that is*, a *half* of the pods are in one group, namely, those that bear two seeds. In other words, the pods of average seed capacity are the ones that equal in number the sum of all others. It will be of interest to determine the comparative viability and vigor in the seeds of these groups.

Table of Weights of Tomatoes Borne in Racemes.

Position	Basal	2	3	4	5	6	Kind.	Remarks.
Weight grams	59	57	57	52	48	...	"Pears" cross.	Five in cluster.
Weight grams	91	80	80	73	66	.	"Plum" cross.	Five in cluster.
Weight grams	233	232	215	212	168	134	"Plum" cross.	Six in cluster.
Weight grams	42	44	49	44	39	34	"Cherry" cross.	Six in cluster.

Where fruits are borne in long clusters (racemes) there is a difference in their size as regard the position in the cluster. This is well shown in the clusters of currants, the fruits being smaller as the tip of the cluster is approached. In making any weights and measurements one needs to be convinced of the full maturity of all the fruits in the cluster. A few weights were made of tomatoes late in the season (October 23) from which the above table is constructed.

In all except the "Cherry" there is a decrease of weight from the basal to the top fruits, the chief decline beginning with the fourth fruit. The "Cherry" shows an increase to the third and then a material decrease.

A similar series of weights was found in the pokeberry (*Phytolacca decandra L.*) where the ripe fruits are numerous in the raceme. Racemes with the berries all mature and their number divisible by three were grouped as basal, middle and tip and their ratio of weights were 14, 16.3, and 15, respectively.

The difference in the weight of grains of corn upon the same cob is a most familiar example of the subject in hand and has been previously mentioned in this report. It is the purpose to make a study of the relation of the position of the grains to the vigor of the plants these kernels produce.

Size of Fruit as Related to Position Upon the Plant.

From a large branch each of many small fruited pepper plants the fully matured fruits were picked in two separate groups, namely, those upon the lower and those upon the upper half and their number and weights taken as follows:

Lower portion number	174	Weight........501 gr.	Average....... 2.88
Upper portion number... ...	141	Weight........371½gr.	Average....... 2.63

This is a difference of practically 10 per-cent., the lower fruits being the larger. A similar gathering of a bushel or so of fruits has been made and are being dried before counting and weighing, because the earlier fruits are apt to be less plump at picking time than those formed later and

A STUDY OF HYPOCOTYL ELONGATION.

Much work was done upon seedling soybeans and commercial beans, but lack of time permits of no more than a fragment being given here. Six kinds of beans were chosen as follows: (1) (bush) "Mohawk"; (2) (pole) "Kentucky Wonder"; (3) (early) "Pencilpod Black Wax"; (4) (late) "Hobson Wax"; (5) (large seeded) "Flageolet"; (6) (small seeded) "Refuge Wax." The seeds were planted in the field July 16th and harvested 16 days later for one 100 and four days later for the second 100. The two hundreds have been calculated together, the difference being an increase of tops in the second hundred. In the greenhouse the duplicate sets were planted one day later and likewise harvested, 100 seedlings each, at the end of 16 days. Below follows a table of the average for the measurements:

Table of Measurement for Beans (1) in the Field and (2) in Greenhouse.

	HYPOCOTYL LENGTH.		FIRST INTERNODE.		TOP.		TOTAL LENGTH.		WEIGHT.	
	Field.	Greenhouse.	Field.	Greenhouse.	Field.	Greenhouse.	Field.	Greenhouse.	Field.	Greenhouse
"Mohawk"	84.85	58.00	44.9	47.00	25.27	137.40	155.02	242.40	4.46	11.65
"Ky Wonder"	90.79	73.10	38.96	34.90	36.88	392.20	166.63	500.20	3.81	9.90
"Pencil Pod	99.25	85.00	44.23	47.50	22.39	88.00	165.87	220.50	4.19	9.50
"Hobson"	73.50	64.10	54.39	49.00	15.36	51.60	143.25	167.40	4.65	10.30
"Flageolet"	84.70	75.19	40.06	43.05	32.12	156.70	156.88	274.94	4.78	11.80
"Refugee"	*75.35*	*64.60*	*37.77*	*33.70*	*8.78*	*19.92*	*121.90*	*118.22*	*3.23*	*7.90*

The above table reduced to the form of rank or position among the several parts makes the following expression:

	HYPOCOTYL.		FIRST INTERNODE.		TIPS.		TOTAL LENGTH.		WEIGHT.		Average of total and weights.
	Field.	Greenhouse.	Field.	Greenhouse.	Field.	Greenhouse.	Field.	Greenhouse.	Field.	Greenhouse.	
"Mohawk"	3	6	2	3	3	3	4	3	3	2	3
"Ky Wonder"	2	3	5	5	1	1	1	1	5	4	2
"Pencil Pod"	1	1	3	2	4	4	2	4	4	5	4
"Hobson"	6	5	1	1	5	5	5	5	2	3	4
"Flagcolet"	4	2	4	4	2	2	3	2	1	1	1
"Refugee"	5	4	6	6	6	6	6	6	6	6	5

The hypocotyls are uniformly much longer in the field than in the greenhouse, those of the "Pencil Pod" being the longest and the "Hobson" the shortest. Just the opposite is the result for the first internode, that is the seedlings with the longest hypocotyls gave the shorest internode and *vice versa*. For length above the first internode the field and greenhouse measurements are parallel and are led by the "Kentucky Wonder" and the shortest are among the "Refugee." The total weights show the

"Flageolet" at the head, followed by "Hobson" and "Mohawk," the "Refugee" being last here as practically everywhere. The last column of ranking figures is made of averages for (1) the total length, and (2) weight.

The "Flageolet" was selected as having a large seed and grown in comparison with the "Refugee," a small slender sort, which it outranked in practically all points. The comparison between bush and pole was made between "Mohawk" and "Kentucky Wonder" and the "Mohawk" (bush) had shorter hypocotyle, longer first internodes and much less tips than the "Kentucky Wonder." For the test of early against late the "Pencil Pod" was compared with the "Hobson" and the early "Pencil Pod" stood first of all in hypocotyl, "Hobson" being last, but for first internode the "Hobson" was first of the six kinds and "Pencil Pod" took a middle rank. In the final outcome of total length and weight the two have the same position, this being due to the superior length of the "Hobson" and greater weight of the shorter stouter "Pencil Pod" seedlings.

B. H. ALFRED GROTH.

HEREDITY AND CORRELATION OF STRUCTURES IN TOMATOES.

In the crosses hetween types with different fruit shape intermediate and new shapes had *often appeared in former years. A few of these had bred* true in the F_3. It was decided to find out whether a majority of such forms can be fixed, in order to throw some light on their meaning. Accordingly 156 lots of seed were selected from the F_3 crop for graded difference in frnit shape of the F_3 plants. All seeds were from selfed flowers. The number of plants totaled equals 4,800. For example, from a cross between the flat "Ponderosa" and the long "Pear" a series of 22 shapes was selected, representing different types of flat, round, plum-shaped, fig-shaped, conical and pear-shaped fruits with a number of intermediates.

It was found that 66 per cent. of the selections bred true to shape, whereas in the previous year (F_3), when selection had been made for fruit length, only about 5 per cent. bred true. The regular appearance of shapes of types not used as parents, together with the size inheritance of the geometric mean reported upon in Bulletin 242 led to the conviction that size and shape characters in tomatoes are greatly dependent upon one another. Of the three long fruit shapes, "Pear," "Fig," and "Plum," either one may throw the other two in crosses with round or flat fruits. It seems certain that the three shapes are only different expressions of one shape factor influenced hy different combinations of size factors. An exposition of the fundamentals of this view was pnblisbed in "Science," April 17, 1914, and a fuller treatise of it will appear in Bulletin * * *.

With this year's work the main part of the problem is considered completed, and only a few minor points will be investigated next year.

Prairie Berry Crosses.

The prairie herry has now been snccessfnlly crossed with both the green-fruited and the red-fruited varieties of *Solanum nigrum*, and some of the F_2 plants were in the field this season. Among a total of about 2,500 F_2 plants none has so far appeared in which the size of fruit and the number of locules have been as great as in the prairie berry itself. An astounding variety in plant size, plant habit, method of hranching; shape, and size of leaf; color and roughness of stem; shape, size, and color of flower; productiveness; size, color, and flavor of fruit, etc., etc., has appeared in the F_2. In fact in practically all characters in which the parents are fixed, the F_2 plants segregate. So far no two plants have been found which are as much alike as different parental individuals. Many of the characters do not occur in either parent. In order to determine whether these might be traced back to ancestral traits, the writer has examined the herbarium specimens of *S. nigrum* at the

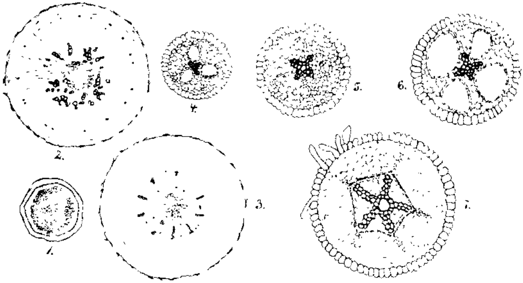

PLATE XII.—*Root and Stem Sections of the Sweet Potato.* 1, Normal Stem; 2, Storage Stem; 3, Storage Root; 4, Root in Pot 5; 5, Normal Root; 6, Root in Swamp; 7, Root in Pot 2.

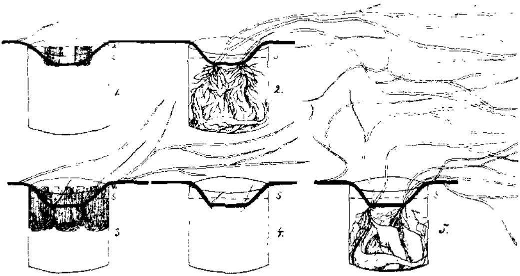

PLATE XIII.—Experiment on Circulation in the Sweet Potato. 1 and 3, Swamp Pots; 2 and 4, Dry Soil Pots; 5, Normal Control; S, Soil Level; W, Water Level.

New York Botanical Gardens and inquired at the Gray Herbarium and the U. S. National Herbarium. It appears that with the exception of dwarfness and the possible exception of differences in flavor all conditions noted may occur in the wild state. So far no natural dwarf specimen has been revealed, although the crosses yielded about 2 per cent. of them.

Several plants with commercially promising fruit characters have been found, one of which bears piebald (green with blue) fruits. The work will be continued.

CONTRIBUTION TO THE STUDY OF CIRCULATION.

Studies on the Sweet Potato (Ipomoea batatas.

The experiment outlined on Plate XXXI of the Annual Report of 1912 was repeated with dark bags, under which no starch formation took place in the leaves. The appearance of small storage roots in pots 1a and 2a showed that the plant is indeed able to transport starch for storage in the distal direction when the proximal direction is cut off; and a potato weighing 70 grams in pot 8a shows likewise that storage roots may develop in dry soil, when the only water supply comes through the plant in the reverse direction. The sweet potato thus showed a remarkable adaptability to abnormal conditions, and two experiments were made to put it to a still more severe test.

It had been noticed in some poison experiments in which a total of .05 per cent. of Na. No.$_3$ had been added to the mixture of soil and sand, that a sweet potato vine planted in it would send out branches which grew more slowly than those of normal plants. An examination of the root revealed that a large number of roots was continually appearing, all of which would grow to the length of a few centimeters and then turn black and die from the tip back. The plant renewed the roots constantly and did not die. This plant was, therefore, allowed to continue growth from May 20 to December 10, 1913. The leaves were tested during the summer and found to contain starch. When the plant was taken up it was seen that the roots were still very feeble, but that the part of the stem which had been placed underground, including two nodes, had increased its diameter from 2 mm. to $\pm$15 mm. The root, somewhat enlarged, is shown in Fig. 1 of the diagram, page 332. It may be seen that the roots spring from it only at the nodes, as they do from stems, and that the leaf scars are plainly visible. A storage root of about the same diameter is shown in Fig. 4. On such roots the rootlets are arranged in $\pm$5 longitudinal rows, and there are no leaf scars. Externally, in regard to color and lentical marking, the two storage organs looked alike. Fig. 2 gives the reverse side of the storage stem, showing the enlarged leaf scars of the stem itself and of an incipient branch in its leaf axil, while Fig. 3 gives for comparison a portion of stem such as was planted to produce the storage stem.

Plate XII, Fig. 1, shows a cross section through a normal sweet potato stem, indicating the relative strength of the cortex, bast-ring, phloem, xylem and fundamental tissue. Fig. 2 shows a similar section through the thinner portion of the storage stem, showing how the xylem has been broken up

by the enlarged medullary rays, and how the bast-ring has been divided into its units. The phloem portion is greatly increased in area. All non-lignified tissues carry some starch, but the medullary rays carry more than the phloem between them, making the rays appear darker under the low power microscope. Fig. 3 represents the section of a storage root of like diameter, showing a greater development of the cortex, and the feeble development of phloem, bast and xylem. The starch resides chiefly in the medullary rays and the fundamental tissue.

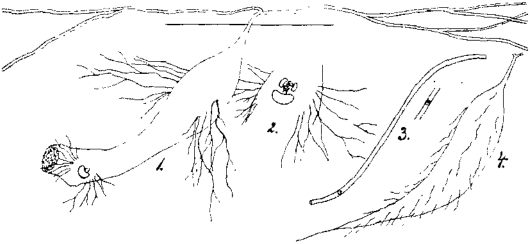

FIGURE I.—Storage Organs of Sweet Potato. 1, 2, Storage Stem; 3, Normal Stem; 4, Storage Root.

The second test is illustrated by Plate XIII. Pot 1 contains soil up to the level S and on top of it standing water to the top of the pot, W. The water of course also saturated the soil, making it a swamp. The experiment was running in the greenhouse from March 10 to October 30, 1914. All pots were one gallon glazed crocks. Water evaporating from the surface was replaced from a larger pot in which it had been standing for a day or more in the greenhouse. The intention was to produce an environment resembling a stagnant swamp. Pot 2 contained a mixture of soil and sand moistened with 10 per cent. of its weight in water. A piece of sweet potato vine was then laid across the two pots so that the base protruded beyond pot 1, the tip beyond pot 2. Two nodes in each pot were then stuck below the surface of the soil. Pot 1 was refilled twice daily as reported above, while pot 2 received no more water during the entire experiment. Pots 3 and 4 were controls, duplicates of pots 1 and 2, but unconnected, while pot 5 contained the same kind of soil as pot 2, but was regularly watered. All plants were started on March 10, 1914, with leaves attached.

By March 18 the leaves in pot 1 began to dry up, while in all other pots new shoots appeared, strongest in pot 5, weakest in pot 4.

On March 26 pot 1 began to make a new shoot on the overhanging basal portion, while the entire plant in pot 4 was wilted and partly drying up. It never revived. In pots 1 and 3 roots began to grow straight up from the mud to the surface of the water. Green algae appeared in both pots.

On April 17 it was noted that roots as well as algae in pot 1 turned brown, seemingly decaying. The water became muddy, and bubbles rose from the scum connecting the roots. At the same time the algae in pot 3 remained green and the water clear. The roots also appeared greenish. The mass of roots was much greater in pot 3 than in pot 1. Portions of the brown scum from pot 1 were put into pot 3, and some of the algæ material from pot 3 into pot 1. The latter turned brown in a few days, while the former remained brown, but did not spread.

About May 15 the short branch on the basal side of pot 1 stopped growth. The leaves turned yellow and later dropped, but the stem never died. From time to time new vertical roots would appear in pot 1, but after a few days they always first turned white, then brown, and then disappeared. In pot 3 the mass of root became more and more matted, taking up practically the entire surface. The water between them always remained clear. Of all pots No. 5 made the heaviest growth in vines, followed in order by pots 2, 3, 1, and 4.

At harvest time, on October 30 only very short, dried up roots were found in pot 4. Pots 1 and 3 contained tufts of upright roots, those of pot 1 rising almost at once from the node, while those in pot 3 had gone down into the soil to a greater extent. Pot 3 contained an abnormally large amount of roots. Pots 2 and 5 contained storage roots, those in pot 5 thicker. The total weight of the thickened roots in pot 2 was 220 grams, in pot 5, 405 grams. While in pot 5 the smaller roots were long, thin and frequently branched, those in pot 2 were fewer, shorter, thicker, kinky, and not much branched. Small particles of most soil adhered to the storage and feed roots, though the pot had received no water since March 10.

Judging from the results obtained, it seemed that this is what had taken place: When the supply of fresh air was shut off from the roots by the stagnant water, they sent rootlets to the surface of the water. This reminds one of the aerating roots of *Taxiodium distichum* as reported upon by W. P. Wilson many years ago, and it is natural to suspect that such roots might be aerating organs. The roots in pot 2 got a small start through the water then in the soil. When that soil water became exhausted, the plant began to depend on the roots in pot 1 for all the water and air for both pots. Soon the water current from pot 1 to pot 2 established normal conditions immediately around the roots in pot 2, so the air supply could be obtained from pot 2, while the water still had to come from pot 1. Therefore the aerating roots in pot 1 stopped functioning and decayed. Periodically probably through excessive transpiration on hot days, pot 2 dried out too much and this again cut off the supply of air to the roots as well. Therefore the original conditions had returned and new aerating roots were formed in pot 1, which subsequently decayed through non-use. Since the zone of moist soil surrounding the roots must be necessarily narrow under the excessive heat conditions prevailing in a greenhouse in summer, the rootlets did not grow long.

Hand sections through the roots (Plate XII) indicate that the above supposition that the upright roots are aerating organs is very likely cor-

rect. Fig. 5 shows a section through an ultimate branch of a normal root, from pot 5. In the sectors between the small xylem masses are found the latex tubes, which are found in all vegetative parts of the plant. Fig. 4 shows, at the same magnification, a section through an ultimate root branch in pot 1. It is thinner than normal, but the latex tubes have been greatly enlarged. It is likely that these latex tubes functioned as air channels while the roots were intermittently acting as aerators. Fig. 6 is a section through the ultimate branch of a root in pot 3, where the roots functioned permanently as aerators. The latex tubes, or air channels, are much enlarged. The entire root is thicker than normal. Fig. 7 represents a section through the ultimate branch of a root in pot 2. It is thicker than any of the others, and the section reveals that this is due to the fact that it is older, i. e., the branching has not proceeded as rapidly. The latex canals are not so conspicuous, only one being clearly recognizable. This condition, however, is normal for older roots. Some of the epidermal cells are much elongated.

It appears then that the sweet potato has difficulty in storing starch in submerged soil, but little difficulty in doing it in air-dry soil, if any portion of its stem has access to water; that it is able to form aerating roots if the soil in which it grows is covered by stagnant water; and that it can store starch in its stem, if the roots are prevented from growing properly. The permanent clearness of the water in pot 3 also suggests that the aerating roots may even have the faculty of making stagnant water fresh.

Poison Experiment.

Owing to a desire to bring the work on Heredity in Tomatoes to completion, the poison experiment was suspended for the season, to be resumed next year

Inheritance Studies in Garden Plants.

EARLE J. OWEN

This branch of work has embraced the four subjects: Beans, Egg-plants, Limitation Studies and Okra, each marking a step forward.

The hulk of the note-taking with beans has dealt with the three Scarlet Runner hybrids discussed in the Annual Report for 1913.

The "Scarlet Runner"-"Black Valentine" group was considered mainly from the standpoint of productiveness.

Scarlet Runner Hybirds F_2.

SUBJECT.	PLANT HABIT.			PRODUCTIVENESS.			SEED COLOR		
	Bush.	Spreading.	Climbing.	Prolific.	Non-prolific.	Sterile.	Male parent.	Intermed.	Female parent.
'S. Runner"—"White Marrowfat" ..	62	13	55	27	44	59	8	20	22
"S. "Runner"—"Davis Wax"....	70	8	33	45	25	18	9	32	11

Taking up the two groups tabulated above in the second generation, the general notes as recorded in 1913 for the "Scarlet Runner"-"Black Valentine" set of plants (F_2) would have described these two equally as well all three running the gamut in variability as to root, plant habit, flower color, pod type and seed color. The climbing habit was, as a rule, correlated with late season while most of the sterile plants were striking in vigor and profusion of bloom. A few shy-bearers were of slow development, resembling the F_1 dwarfs of last year and producing flowers which were not normal. Three or four plants were of the "filiform" type, none of which bore fruits. Most of the bush plants were early, while those denoted as "spreading" represent an intermediate type as to season and habit of growth. It should be stated that notes on productiveness were taken late in August and the "sterile" plants included all free bloomers not yet fruiting. Many of these set pods later and at harvest time were recorded as "non-prolific" which explains the large number of sterile individuals. Both female parents, "White Marrowfat" and "Davis Wax," are white seeded and the larger proportion of "whites" in the "Scarlet Runner"-"White Marrowfat" set is due to the fact that the offspring from the white seeded F_1 parent (Annual Report 1913) totaling twenty-three plants, record fourteen white and nine dark.

This occurrence of a white seeded offspring in the F_1 generation where one parent is dark seeded ("Scarlet Runner") has never been found in any of the crosses between varieties of *Phaseolus vulgaris*, presenting a new phrase of the color problem to be worked out through the production

of more hybrids already attempted and a more detailed study of inheritance along this particular line.

Referring to "seed color," the "intermediate" column indicates all mottled forms which could not be classed as "mottled purple" ("Scarlet Runner" type), also "black," "mottled brown" and "mottled gray." This mottled gray type has cropped out in all the hybrids thus far studied and that it will breed true is already proved in its selection from the "Scarlet Runner"-"Tennessee" set, this strain being grown the past season in the seventh generation and breeding true in every instance. The black seed of the hybrid, unlike "Black Valentine," is not always associated with a pink flower, but sometimes with a crimson or nearly white bloom for the apparently colorless flower on closer examination is often found to be faintly striped or marked with color. Extensive notes were taken in regard to other characters as flower color, season and pod color, these being reserved for a later publication.

"Black Valentine"-"Davis Wax" (45-112F_3). This cross closely studied last year in the second generation has been grown this season mainly for data on the inheritance of the four seed colors, the black and the white of the parents "mottled" (F_1 type) and "light mottled." The black, the white and the "light mottled" all bred true, while the "mottled" broke up again but gave no whites due possible to small numbers.

Three novelties, "Station Snapbean No. 3," a green podded stringless selection, and the "mottled gray" of the "Scarlet Runner"-"Tennessee" set, also the two strains from "Black Turtle Soup," "dull" and "glossy," were grown for preservation.

Of the commercial sorts grown for breeding purposes, "Scarlet Runner" and "Kentucky Wonder" were perhaps of most value, offering good material for basis work, both being parents of future crosses.

Eggplants.

The table below represents in brief the season's record of the twelve eggplant varieties which were grown, also the established strain of the hybrid ("Dwarf Purple"-"Scarlet Chinese") and two old crosses, a total of 211 plants.

VARIETY OR CROSS.	Plants grown.	Height of plant.	Fruits per plant.	Per cent. decay Oct. 21
4—"Black Beauty"	10	31 cms.	2	75.
6—"Dwarf Purple"	10	38 "	8.4	47.
8—"Florida High Bush"	6	65 "	4	8.
9—"N. Y. Improved Spineless"	5	31 "	2	20.
11—"Long White	10	60 "	7.7	20.
12—"Long Purple"	10	59 "	6.3	11.
21—"Striped"	10	44 "	10	12.
25—"Scarlet Chinese"	11	79 "	70	8.
26—"Ivory"	20	64 "	8.5	20.
29—"Round White"	10	53 "	12.5	9.
34—"Round Purple"	10	44 "	5.5	49.
40—"U. S. D. A."	10	43 "	45	10.
"Long White,"-"Dwarf Purple" (11-6 F_3)	50	46 "	7.1	34.
"Ivory"-"Black Beauty" (26-4 F_2)	10	41 "	6	50.
"Dwarf Purple,"-"Scarlet Chinese" (6-25-6)	40	65 "	10	10.

All crosses showed vigor and fruitfulness throughout the season, the "Ivory" and "hybrid" strains leading in this respect. Spineless individuals of the "Scarlet Chinese" and "Dwarf Purple" varieties were found and crosses made with them for the purpose of studying this character as to its behavior in the offspring. The "hybrid" ("Dwarf Purple"-"Scarlet Chinese") already described in a previous annual and represented this season by forty plants, possessed its usual vigor, uniformity and fruitfulness, also good table quality. But it is decidedly spiny and for this reason is being bred with the "Spineless Round Purple" in the expectation of removing the spines, while keeping the desirable qualities. Selection was made from the "Scarlet Chinese" of a non-prolific plant (50 fruits) and a prolific one (125 plants) as a basis for the study of this character in its bearing on heredity. A similar selection was made from the commercial varieties.

Limitation Studies.

These experiments, as the table indicates, have continued not only with beans and eggplants, but with tomatoes, okra and peppers, data for these three not being ready for a report at this time.

SUBJECT.	Plants grown.	Blooms per plant.	Fruits per plant.	Weight of plant.	Weight of single fruit.
"Black Valentine"					
Full crop	10	32.5	19.0	17.5	.3
One pod	10	281.8	1	159.7	.45
No pods	8	305.9	....	191.6	......
"Davis Wax"					
Full crop	9	34.	11.8	17.1	.45
One pod	10	270 5	1	109.1	.55
No pods	10	303.6	....	120.7	......
"Dwarf Purple"—Eggplant					
Full crop	5	9.2	3.	49	75 8
One fruit	5	42 2	1.	240.4	320.
No fruit	5	71.8	....	484.2	......
"Long White"					
Full crop	5	11.	5.8	266.4	162.7
One pod	5	60.8	1.	731.8	340.4
No pods	5	92.2	..	960.2	......

A perusal of the several columns will show that, as heretofore, limiting the yield of a plant to one fruit greatly increases the size of plant and, to a lesser extent, the size of fruit. The root system is also affected in a similar manner, especially with the eggplants, but no detailed records as to size and weight were obtained. As it is planned to complete this experiment with the tenth generation, progeny from the one-fruited bean plants will be the first subject tested as to inheritance of increased fruit size, these having been carried to the seventh generation.

Okra.

Three varieties of this vegetable were grown for purposes of breeding "Dwarf Prolific," "White Velvet" and "Holt's Prolific Early Green." Four generations of the hybrid *(Hibiscus esculentus-Hibiscus Manihot)* were studied representing thirty plants, all remarkably uniform. They began

blooming late in June and continued until October, attaining a height of from five to six feet. Three related species were also under observation for hybridizing, "Golden Bowl" *(Hibiscus Manihot)*, "Roselle" *(Hibiscus Sabdariffa)* and *Hibiscus Africanus*, the last being a horticultural species nearly related to the familiar weed "Flower of an Hour" *(Hibiscus Trionum.)*

Attempts made to hybridize the "Marsh Mallow" *(Hibiscus Moscheutos)* with the hybrid and with the "Althea" *(Hibiscus Syriacus)* were unsuccessful.

Report of the Entomologist.

THOMAS J. HEADLEE, PH. D.

GENERAL OUTLINE OF WORK.

The attention of the entomologist has been devoted this year to furnishing information and other assistance, insofar as his means would permit, as the need arose. He has also carried forward investigations of anti-peach-borer coatings, of the effect of various sprays and dusts on potato foliage and yield, and of the problems of house fly and mosquito control.

Staff Personnel and Acknowledgments.

The present year has seen a considerable amount of change in the staff. Miss Augusta E. Meske has continued her efficient management of the clerical affairs of the office. Mr. C. H. Richardson, Jr., took up and carried on the work against the house fly and its allies. On April 1st Mr. A. E. Cameron, who holds a scholarship of the Board of Agriculture of England, joined the force for the purpose of gaining practical experience in field methods of insect control. He was given charge of the potato foliage work and carried it forward in an eminently satisfactory manner. Mr. Herman H. Brehme, chief inspector in mosquito extermination work, resigned on November 30, 1913. Mr. Joseph S. Obecny resigned on March 31st to take up the management of his farm and greenhouse plant on Long Island. On June 1st Mr. Charles S. Beckwith was appointed as temporary assistant in mosquito work and has been appointed a member of the permanent force; his appointment is to take effect November 1st.

CORRESPONDENCE.

General Statement.

The correspondence of the present year has involved the handling of approximately 6,000 regular letters, about one half of which were written in this office. In addition to this work at least 2,000 circular letters have been sent out. 915 letters concerning specific pests have been written for the purpose of giving requested information relative to habits and methods of control.

Tabular Statement.

ARACHNIDA.

Bryobia pratensis, Garman	Clover Mite	Grenloch	May 25
Eriophyes aenigma	Mite	Keansburg	July 15
Eriophyes sp	Gall Mite	Palmyra	July 9
Tetranychus sp.	Red Spider	Newark	July 27
" "	Red Spider	Newark	July 20
" "	Mite	Quinton	Oct. 1
" "	"	Westville	Oct. 12
" "	"	Madison	Sept.
Dermacentor americanus, L.	Dog Tick	Cream Ridge	June 4

INSECTA.

THYSANURA.

Latin Name.	Common Name.	Locality.	Date.
Thermobia domestica Pack	Silver Fish	Englewood	Sept. 1
THYSANOPTERA.			
Thrips tabaci, Linden	Onion Thrips	E. Moriches, L.I., N.Y.	Aug. 13
HOMOPTERA.			
Aphis brassicæ, Linn.	Cabbage Aphis	Paterson	Oct. 15
Aphis gossypi, Glover	Melon Aphis	Dias Creek	July 8
" " "	" "	Arlington	July 20
" " "	" "	Somerville	Sept. 2
Aphis mali, Fabr.	Apple Aphis	Bloomfield	June 1
" " "	" "	Deal	June 4
" " "	" "	Somerville	June 11
" " "	" "	Dias Creek	July 8
" " "	" "	Scotch Plains	Sept. 24
Aphididæ	Plant Lice	Mt. Holly	June 30
"	" "	Chatsworth	Sept. 14
"	" "	Middletown	May 24
"	Root Lice	Mullica Hill	June 19
"	Plant Lice	Elizabeth	June 25
"	" "	So. Bound Brook	June 29
"	Green Lice	Rockaway	July 1
"	Green Root Louse	Palmyra	July 7
"	Plant Lice	Jersey City	July 15
"	" "	Elizabeth	July 18
"	" "	Rahway	July 20
"	" "	Pennington	July 30
"	" "	Orange	Aug. 7
"	" "	Somerville	Aug. 10
"	" "	Trenton	Aug. 18
"	" "	Metuchen	Aug. 20
"	" "	Trenton	Aug. 31
"	" "	Trenton	Sept. 16
"		Lakewood	Oct. 23
Aspidiotus hederæ, Vail	Oleander Scale	Montclair	Mar. 17
Aspidiotus perniciosus, Vall.	San Jose Scale	Mason City, W. Va.	Jan. 26
" " "	" " "	Watchung	Mar. 6
" " "	" " "	Princeton	May 14
" " "	" " "	Haddonfield	June 8
" " "	" " "	Springfield	June 19
" " "	" " "	New York City	June 22
" " "	" " "	Haddonfield	June 24
Aulacaspis rosæ, Bouche	Rose Scale	Vineland	Mar. 11
Chermaphis (Chermes) abieticolens. Thos.	Spruce Gall Louse	Rutherford	Sept. 26
" pinicorticis Fitch	Pine Bark Aphid	Salem	Jan. 29
" " "	" " "	New Brunswick	May 21
" " "	" " "	East Orange	June 3
" " "	" " "	Lambertville	Sept. 11
Chionaspis enonymi, Comst.	Enonymous Scale	Tenafly	Mar. 31
" " "	" "	Ocean City	May 5
" " "	" "	Moorestown	July 31
Chionaspis furfurus, Fitch	Scurfy Scale	Jersey City	June 22
Chionaspis pinifoliæ, Fitch	Pine Leaf Scale	New Brunswick	May 21
Colopha ulmicola, Fitch	Cox-Comb Gall-Louse	Locust	June 22
Diaspis carueli, Targ.	Juniper Scale	Salem	April 30
" " "	" "	New Brunswick	May 6
" " "	" "	Convent	June 14
Eulecanium tulipiferæ, Cook.	Tulip Soft Scale	Tenafly	Feb. 19
Eulecanium sp.	Soft Scale	Trenton	July 13
Gossyparia spuria, Mod.	Elm Scale	Mt. Holly	June 30
Icerya purchasii, Mask.	Cottony Cushion Scale	Princeton	Feb. 16

Tabular Statement—Continued.

HOMOPTERA—Continued.

Latin Name.	Common Name.	Locality.	Date.
Lepidosaphes ulmi, Linn.	Oyster-Shell Scale	Pine Brook	April 17
" " "	" " "	Whippany	April 2
" " "	" " "	Jersey City	April 27
" " "	" " "	Westfield	May 15
" " "	" " "	Plainfield	June 2
" " "	" " "	New York City	June 2
" " "	" " "	Hackensack	June 6
" " "	" " "	Springfield	June 19
" " "	" " "	Woodcliff on Hudson	Aug. 24
		Ocean Grove	Sept. 29
Myzus persicæ, Sulz.	Green Peach Aphis	Moorestown	Oct. 17
Myzus ribis, Linn.	Currant Aphis	Moorestown	Oct. 12
" " "	" "	East Orange	May 4
" " "	" "	Johnsonburg	May 7
" " "	" "	East Orange	May 11
" " "	" "	Westfield	May 13
" " "	" "	Dunellen	May 18
" " "	" "	Roselle	June 21
" " "	" "	Haddonfield	June 24
Nectarophora pisi, Kalt.	Pea Louse	Budds Lake	May 11
" " "	" "	Grenloch	June 17
Nectarophora rosæ, Linn	*Rose Aphis*	Paterson	May 27
Pemphigus sp.	Poplar Gall-Louse	East Orange	June 24
Phenacoccus acericola, King	Maple Pseudococcus	Tenafly	Feb. 19
Phylloxera vastatrix, Planch.	Grape Phylloxera	West End	July 17
" " "	" "	Westfield	July 30
" " "	" "	Madison	Aug. 19
Pseudocuccus sp.	Mealy Bug	Springfield	July 3
" "		Newton	Sept. 15
Psylla pyricola, Forst.	Pear Psylla	Magnolia	July 7
" " "	" "	Bridgeton	Sept. 14
Rhopalosiphum solani, Thos.	Tomato Aphis	Phillipsburg	July 10
" " "	" "	Clifton	July 13
" " "	" "	Mt. Ephraim	July 16
" " "	" "	Arlington	July 20
" " "	" "	Newark	June 23
" " "	" "	Elmer	June 29
Saissetia hemisphærica, Targ	Hemispherical Scale	Verona	July 4
Saissetia sp.	Soft Scale	Rahway	June 17
Schizoneura lanigera, Hausm.	Wooley Apple Aphis	Deal	June 4
" " "	" " "	Locust	June 22
" " "	" " "	Passaic	June 1
" " "	" " "	Elizabeth	June 22
" " "	" " "	New York City	July 6
" " "	" " "	Swainton	Oct. 13
" " "	" " "	Vineland	Oct. 16
Typhlocyba comes, Say	Grape Leaf-hopper	Hightstown	Sept. 23
" " "	" " "	Glassboro	Sept. 29
" " "	" " "	Merchantville	Sept. 29
Typhlocyba rosæ, Linn.	Rose leaf-hopper	Dover	June 12
Typhlocyba rosæ, Linn.	Rose leaf-hopper	Montclair	June 17

HEMIPTERA.

Anasa tristis, De G.	Squash Bug	W. Collingswood	July 13
Arilus cristatus, Linn.	Wheel Bug	Freehold	March 24
" " "	" "	Burlington	Aug. 15
Miridæ (Capsidæ)	Plant Bug	Plainfield	June 29
Coreidae	Bug	Swedesboro	Aug. 8
Hormias goniphorus, Say		Hamden	July 2
Leptobyrsa, explanta Heid	Rhododendron Lace Bug	Lambertville	Oct. 15
Lygus kalmii, Stal.		Elmer	June 29
Pœcilocapsus lineatus, Fab.	Four-lined Leaf-bug	East Orange	May 4
" " "	" " "	New Brunswick	June 5
" " "	" " "	Hamden	July 2

ORTHOPTRA.

Acrididæ.	Grasshoppers	Medford	Aug. 29
Blatta orientalis Linn.	Oriental Cockroach.	New Brunswick	May 21
Blattidæ.	Roaches	Richwood	July 8
Diapheromera femorata, Say.	Walking Stick	Westfield	Sept. 15
Gryllus domesticus, Linn.	House Cricket	Highland Park	Aug. 24
Locustidæ.	Meadow Grasshopper	Medford	Aug. 29
Microcentrum sp.	Katydid	Bound Brook	Mar. 3
Paratenodera sinensis, Sauss.	Chinese Mantis	Palmyra	Aug. 24

Tabular Statement—Continued.

COLEOPTERA.

Latin Name.	Common Name.	Locality.	Date.
Agrilus ruficollis, Fab.	Red-necked Caneborer	Sewell	Feb. 19
Allorhina nitida, Linn.		Paterson	July 16
" " "		Lambertville	July 18
Amphicerus bicaudatus, Say	Apple twigborer	Hammonton	May 8
Anthonomus signatus, Say	Strawberry Weevil	Medford	May 17
" " "	" "	Moorestown	May 18
" " "	" "	Hammonton	May 19
" " "	" "	Millville	May 19
Apion nigrum, Herbst	Black Locust Apion	New York City	June 1
Attagenus piceus, Oliv	Black Carpet beetle	New Brunswick	April 22
" " "	" " "	Nutley	Aug. 4
" " "	" " "	Nutley	Aug. 17
Buprestidæ	Flat-headed borer	Rutherford	Aug. 5
Calandra oryzæ, Linn.	Rice Weevil	Butler	April 27
Calosoma scrutator, Fabr.	Firey Searcher	Wildwood	May 18
Chauliognatus marginatus, Fabr.	Lampyrid	Far Hills	June 2
Chrysomelidæ	Leaf beetle	Westfield	Aug. 18
Coccinellidæ	Lady Bird sp.	Trenton	Aug. 31
Conotrachelus nenuphar, Hbst.	Plum curculio	Middletown	May 28
" " "	" "	Camden	June 2
" " "	" "	Plainfield	June 4
" " "	" "	Ogdensburg	June 10
" " "	" "	U. Montclair	June 15
" " "	" "	Clementon	June 17
" " "	" "	Pennington	June 22
" " "	" "	Clementon	July 3
" " "	" "	U. Montclair	July 6
" " "	" "	Short Hills	July 8
" " "	" "	Montclair	July 10
" " "	" "	New York City	July 20
" " "	" "	Franklinville	Aug. 3
" " "	" "	South Orange	Sept. 9
Crepidodera rufipes, Linn.		New York City	June 1
Crioceris asparagi, Linn.	Asparagus beetle	Greenwich	May 18
" " "	" "	Trenton	June 9
Cyclocephala villosa, Burns.	June Bug	Paterson	May 9
Dermestidæ	Carpet Beetles	Port Norris	Sept. 23
Diabrotica vittata, Fab.	Striped Cucumber beetle	Grenloch	June 4
" " "	" " "	Bay Head	June 23
" " "	" " "	W. Collingswood	July 13
" " "	" " "	New York City	Sept. 3
Elaphidion villosum, Fab.	Oak twig Pruner	Red Bank	June 22
" " "	" " "	Convent	Aug. 17
" " "	" " "	Ramsey	July 18
" " "	" " "	New York City	July 18
" " "	" " "	Belleplain	Sept. 11
Elateridæ, sp	Wire worms	Mt. Holly	Aug. 29
Elateridæ sp.	Wire worms	Short Hills	Sept. 6
Epitrix cucumeris, Harr.	Potato Flea Beetle	Cranbury	May 23
" " "	" " "	Mullica Hill	May 25
" " "	" " "	Moorestown	May 28
" " "	" " "	Newark	June 23
Epitrix parvula, Fab.	Flea Beetle	New Brunswick	May 20
Galerucella luteola, Mull	Elm Leaf Beetle	Mt. Holly	June 30
Hippodamia convergens, Guer.	Lady Bird	Hackensack	July 27
Hippodamia glacialis, Fab.	Lady Bird	Trenton	Sept. 16
Ithycerus nova-boracensis, Forst.		New York City	May 11
Lachnosterna tristis, Fab.	May Beetle	Pompton Plains	May 15
Lachnostera sp.	" "	New York City	May 11
" "	" "	Far Hills	May 20
" "	" "	Plainfield	June 4
" "	" "	Princeton	June 12
" "	" "	Mullica Hill	June 19
Leptinotarsa 10-lineata, Say	Colorado Potato-beetle	Hackettstown	July 14
" " "	" " "	Sussex	July 20
" " "	" " "	Swedesboro	Aug. 8
" " "	" " "	Short Hills	Sept. 16
Lyctus striatus, Mels.	Powder Post Beetle	Harmony	Aug. 13
Macrodactylus subspinosus, Fabr.	Rose Chafer	Eldora	June 3
" " "	" "	Westville	June 10
" " "	" "	Haddon Heights	June 10
" " "	" "	Vineland	June 14
" " "	" "	Hamilton Square	June 16

Tabular Statement—Continued.

COLEOPTERA—*Continued.*

LATIN NAME.	COMMON NAME.	LOCALITY.	DATE.
Macrodactylus subspinosus, Fabr.	Rose Chafer	Bay Head	June 23
" " "	" "	Elmer	June 29
Megilla fuscilabris, Muls.	Lady Bird	Swedesboro	Oct. 19
Meloidæ sp.	Blister Beetles	Roselle Park	July 7
Molamba fasciata, Say		Tenafly	June 5
Monarthrum fasciatum, Say	Scolytid	Tenafly	June 5
Monocrepidius lavidus, Deg.	Elaterid	Glassboro	July 9
Nodonta puncticollis, Say	Leaf Beetle	Princeton	June 1
Nodonta punct collis, Say	*Leaf Beetle*	*Fair Lawn*	June 29
Odontata dorsalis, Thunb.		New York City	June 1
Phlœotribus liminaris, Harr.	Peach Bark Beetle	Farmingdale	Oct. 28
Pissodes strobi, Peck	White Pine Weevil	Bernardsville	July 10
" " "	" " "	Lynnfield, Mass.	Aug. 17
" " "	" " "	Lynnfield, Mass.	Sept. 15
Pterocyclon mali, Fitch	Scolytid	Tenafly	June 5
Scolytus quadrispinosus, Say	Hickory Bark Beetle	*N. Arlington*	*July* 22
Scolytus quadrispinosus, Say	Hickory Bark Beetle	Convent	Aug. 17
Scolytus rugulosus, Ratz.	Fruit Bark Beetle	Nutley	June 28
Scolytus rugulosus Ratz.	Fruit Bark Beetle	U. Montclair	July 3
Scolytus rugulosus, Ratz.	Fruit Bark Beetle	Mahwah	Sept. 15
Scolytus rugulosus, Ratz.	Fruit Bark Beetle	Farmingdale	Oct. 29
Serica trociformis Burm		Cedar Crest	May 11
Tribolium ferrugineus, Fab.		*Butler*	*April* 27
Trichius piger, Fab.		Merchantville	June 27
Trichobaris trinotata, Say	*Potato Stalk Borer*	*Flemington*	July 11
Trichobaris trinotata, Say	Potato Stalk Borer	Mays Landing	June 27
Trogoderma sp.	Dermestid	New Brunswick	June 25
Xyloteres politus, Say	Scolytid	Tenafly	June 15

LEPIDOPTERA.

LATIN NAME.	COMMON NAME.	LOCALITY.	DATE.
Acronycta oblinita, Sm-Abb.	Dagger Moth	Swedesboro	Oct. 12
Anarsia lineatella, Zell.		Metuchen	Aug. 29
Archips rosaceana, Harr.	Rose Leaf Roller	Bayonne	June 1
Callosamia promethea, Dru.	Promethea Moth	New York City	May 15
Cydia pomonella, Linn.	Codling Moth	Somerville	July 14
Ceratomia catalpæ, *Bdv.*	*Catalpa Sphinx*	*Swedesboro*	*Sept.* 15
Citheronia regalis, Fab.	Hickory Horned Devil	Berlin	Sept. 8
Coleophora fletcherella, Fern.	Cigar Case Bearer	W. Virginia	July 15
Datana integerrima, G. & R.	Black Walnut Caterpiller	Hackettstown	Aug. 23
Desmia furneralis, Hbn.	Grape Leaf Roller	New Brunswick	May 28
Geometridæ	Canker Worm	Dover	June 12
Heliothis obsoleta, Fab	Corn Ear Worm	Hackensack	June 5
" " "	" " "	Somers Point	June 22
" " "	" " "	Great Meadows	July 20
Hemerocampa *leucostigma, S.A.*	White-marked Tussock Moth	Newton	June 26
Hyphantria cunea, Dry.	Fall Web-worm	New York City	Sept. 3
Leucania unipuncta, Harr.	Army Worm	Shrewsbury	June 16
" " "	" "	Ocean Grove	July 13
" " "	" "	Atlantic City	July 13
" " "	" "	Trenton	July 15
" " "	" "	Mullica Hill	July 16
" " "	" "	Trenton	July 16
" " "	" "	Richwood	July 16
" " "	" "	Blackwood	July 17
" " "	" "	Hackensack	July 17
" " "	" "	Haddonfield	July 17
" " "	" "	Newton	July 17
" " "	" "	Philadelphia	July 18
" " "	" "	*Bordentown*	July 18
" " "	" "	Little Silver	July 20
" " "	" "	Long Branch	July 21
" " "	" "	New York	July 21
" " "	" "	New Brunswick	July 21
" " "	" "	New York City	July 21
" " "	" "	New Brunswick	July 22
" " "	" "	West End	July 22
" " "	" "	Belmar	July 23
" " "	" "	*Morristown*	July 23
" " "	" "	Grantwood	July 24
" " "	" "	Hammonton	July 24
" " "	" "	New York City	July 21
" " "	" "	New Brunswick	July 22
" " "	" "	West End	July 22

Tabular Statement—Continued.

LEPIDOPTERA—Continued.

Latin Name.	Common Name.	Locality.	Date.
Leucania unipuncta Harr	Army Worm	Belmar	July 23
" " "	" "	Morristown	July 23
" " "	" "	Grantwood	July 24
" " "	" "	Hammonton	July 24
" " "	" "	New York City	July 24
" " "	" "	Tenafly	July 25
" " "	" "	Princeton	July 25
" " "	" "	Westfield	July 25
" " "	" "	Jersey City	July 28
" " "	" "	New York City	July 31
" " "	" "	Plainfield	Aug. 23
" " "	" "	Atlantic Highlands	Sept. 14
Macronoctua onusta, Grt.	Noctuid	Orange	June 14
Malacosoma americana, Fabr.	Apple-tree Tent-caterpillar	Phalanx	Feb. 20
" " "	" " " "	*Allendale*	May 18
" " "	" " " "	Allendale	May 22
" " "	" " " "	New York City	June 2
" " "	" " " "	Oxford	July 1
" " "	" " " "	Hackettstown	July 14
" " "	" " " "	*Lodi*	Sept. 9
Malacosoma disstria, Hbn.	Forest Tent Caterpillar	Newton	June 5
Melittia satyriniformis, Hbn.	Squash Borer	Lyndhurst	Aug. 27
Mineola vaccinii, Riley	Cranberry-fruit Worm	New York City	Aug. 17
" " "	" "	Plainfield	Aug. 18
Noctuidae sp.	Cut Worm	New Brunswick	May 8
" "	" "	East Moriches, Long Island, N. Y.	May 25
" "	Noctuid	Asbury Park	June 26
Oxyptilus periscelidactylus, Fitch	Grape Plume Moth	Nutley	May 26
Papaipema nitela, Gn.	Dahlia stalkborer	Trenton	July 14
" " "	" "	Sterling	Aug. 10
Papilio polyxenus, Fab.	Swallow-tail Butterfly Caterpillar	Jamesburg	Aug. 1
Phlegethontius carolina, Linn.	Tomato Worm	Glen Gardner	Aug. 21
" " "	" "	Washington	Aug. 28
Rhyacionia frustrana, Scudd.		Trenton	Aug. 19
Rhyacionia sp.		Bass River	Feb. 21
Mineola indiginella, Zell.	Rascal Leaf-crumpler	New York City	May 11
Pieris rapæ, Linn.	Imported Cabbage Worm	Califon	July 15
Pinipestris simmermanni, Grt.	Pine Tip Moth	New Brunswick	May 21
Podosesia syringæ, Harr.	Lilac Borer	Riverton	June 20
Sanninoidea exitosa Say	Peach Borer	Mendham	May 22
" " "	" "	New York City	May 26
" " "	" "	*New York City*	June 1
" " "	" "	Titusville	June 2
" " "	" "	Califon	June 5
" " "	" "	Morristown	July 7
" " "	" "	Roselle Park	July 7
" " "	" "	Naughbright	Aug. 1
" " "	" "	Brooklyn, N. Y.	Aug. 31
" " "	" "	Haddon Heights	Sept. 7
" " "	" "	Woodbridge	Sept. 21
" " "	" "	Interlaken	Oct. 5
" " "	" "	New York City	Oct. 12
" " "	" "	Phillipsburg	Oct. 27
Schizura concinna, S. and A.	Red-Humped Apple-caterpillar	Hackensack	July 17
Sesia *tipuliformis*, Linn.	Imported Currant Borer	Haddonfield	June 24
Sibine stimulea, Clem.	Saddle-back Caterpillar	Rosedale	Aug. 18
" " "	" "	Trenton	Sept. 24
Thyridopteryx ephemeræformis, Steph	Bag Worm	Passaic	July 18
Thyridopteryx ephemeræformis, Steph	" "	Plainfield	Aug. 10
Thyridopteryx ephemeræformis, Steph.	" "	Atlantic Highlands	Aug. 23
Vanessa antiopa, Linn.	Spiny Elm Caterpillar	Riverton	Aug. 6
Zeuzera pyrina, Fab.	Leopard Moth	*Long* Branch	June 15

HYMENOPTERA.

Latin Name.	Common Name.	Locality.	Date.
" " "	" "	Atsion	Mar. 11
Apis mellifera, Linn.	Honey Bee	Morganville	July 18
Caliroa limacina, Retz.	Pear Slug	Somerville	June 11

Tabular Statement—Continued.

Latin Name.	Common Name.	Locality.	Date.
HYMENOPTERA—Continued.			
Camponotus herculeanus pennsylvanicus, *DeG.*	*Carpenter Ant*	*New York City*	Sept. 10
Chrysididæ sp.	Cuckoo Bee	Highlands	July 15
Endelomyia æthiops. Fab.	Rose Slug	Dover	June 12
Formicidæ sp.	Ants	*Nutley*	Aug. 17
" "	Black Ants	Westfield	May 9
" "	Ants	Merchantville	June 1
Ichneumonidæ sp	*Ichneumon Fly*	*Princeton*	Aug. 17
Megarhyssa lunator, Fab.	Long-tailed Ichneumon	Lambertville	Aug 17
" " "	" "	New Brunswick	Aug. 21
Monophodnoides caryæ, Nort.	*Hickory Woolly Worm*	*Belford*	Aug. 17
Monophadnoides rubi, Harr.	Raspberry Saw Fly	Hammonton	May 25
Odynerus tigris, Sauss.	Wasp	Highlands	July 25
Rhodites rosæ, Linn.	*Mossy Rose-gall*	*Little Falls*	*May 4*
Tomostethus bardus, Say	Saw Fly	Far Hills	June 2
SPHONAPTERA.			
Ctenocephalus canis, Curt.	Cat and Dog Flea	Rahway	July 31
" " "	" " "	Ridgefield	Aug. 15
" " "	" " "	Red Bank	Aug 26
DIPTERA.			
Aedes cantator, Coq.	Brown Salt Marsh Mosquito	Paterson	May 27
" " "	Brown Salt Marsh Mosquito	Elizabeth	July 21
Calliphora erythrocephala	*Blow Fly*	*Morristown*	*July 20*
Tasioptera vitis O. S.	Grape Vine Potato Gall	Rutherford	July 30
Cecidomyiidae sp.		West End	July 17
" "		*Titusville*	*Aug. 14*
" "		Mahwah	Aug. 17
" "		Mahwah	Aug. 24
Contarinia pyrivora, Riley	*Pear Midge*	*New Brunswick*	Aug. 5
Culex pipiens. Linn.	House Mosquito	Paterson	May 27
Culicidae sp.	Mosquitos	Fon Du Lac. Wis	May 27
Dasyneura leguminicola, Lint.	*Clover Seed Midge*	*Bound Brook*	*June 12*
Lucilia cæsar, Linn	Green Bottle Fly	Morristown	July 20
Mayetiola destructor, Say	Hessian Fly	Hampton	May 29
" " "	" "	*East Orange*	*May 31*
" " "	" "	Frenchtown	June 12
" " "	" "	Newark	June 24
" " "	" "	*Hackettstown*	*July 14*
" " "	" "	Flemington	Aug. 25
Musca domestica, Linn.	House Fly	Leonia	June 2
Phorbia brassicæ, Bouche.	Cabbage Maggot	*Hightstown*	*May 28*
" " "	" "	Medford	June 9
" " "	" "	Westville	June 10
Phorbia cepetorum, Meig.	Imported Onion Maggot	*New York City*	*July 9*
" " "	" " "	*Hackettstown*	*Oct. 15*
Phorbia sp.	Onion Maggot	Grenloch	May 23
Phorbia sp.	" "	*Manahawkin*	*June 18*

INSECTS OF THE YEAR.

Grape Leaf-Hopper.

(*Typhlocyba comes* Say)

The grape leaf-hopper has this year been unusually abundant and has done a large amount of damage. Indeed, the writer is convinced that not only this year but for several years passed, the damage done by this insect has been much larger than most of the grape growers suspect. Many of the vineyards of south central New Jersey were this summer so badly infested that disturbing the vines in late August and early September caused the hoppers to rise in clouds. The fact that these creatures are sucking insects and do not cut or chew the foliage is probably the condition that has led growers to disregard them. It is interesting to note

that Hartzel* found the vines protected from leaf-hopper attack to have from 8 to 68 per cent. more sugar in the berries than had the fruit from the unprotected vines.

Spraying experiments in New York† have clearly shown that "Black-leaf 40" used at the rate of 1 part to 1,600 parts of water or Bordeaux destroyed the hoppers. To get best results this treatment should be applied while the hoppers are immature, and must be made with sufficient care to wet all individual insects. Owing to the fact that the young hoppers congregate on the lower shoots, which are of little value and hard to spray, it is recommended that these shoots be removed just before the application is made.

Pear Psylla.

(*Psylla pyricola* Forst.)

For several years past this insect has been giving serious trouble at various points in the state. From Riverton, Vineland, Moorestown and Phalanx formal complaints have been received by the writer and in many other places he has seen evidence of its work.

Taking care not to injure the trees, the rough bark should be scraped from the trunks and larger branches and all trash about the orchard should be cleaned up in order that the psyllas may have no good shelter in which to pass the winter. This scraping may be done at any time when time is available. It is probable, however, that the best time for the operation, from all standpoints, is the early fall. At this time the living bark is hardening and psyllas are not yet in hibernation. The studies of Hodgkiss‡ show that during warm spells in November and December the adult psyllas emerge from the crevices in which they have sought shelter and move sluggishly about over the trees, and that at such times a thorough treatment with a mixture composed of three-fourths of a pint of "Black-leaf 40" to 100 gallons of water with soap added at the rate of three to five pounds will destroy all that are hit. The delaying of the dormant treatment with lime-sulphur for San Jose scale until the buds are about ready to open has been shown to destroy such eggs as have been laid. By the time the petals have fallen most of the eggs have hatched and the young have concentrated about the bases of the fruit stems and leaf stalks. A thorough treatment at this time with a mixture composed of three-fourth of a pint of "Black-leaf 40" to 100 gallons of water to which from 3 to 5 pounds of soap have been added will destroy all that are hit. Thorough work at this time will usually destroy nearly all of the insects.

In badly infested orchards it is advisable to use the four treatments mentioned—scraping, fall spraying, delayed winter strength lime-sulphur treatment and blossom fall spraying. In view of the success in using the "Black-leaf 40" combined with Bordeaux or summer strength lime-sulphur against aphis and red bug the writer sees no reason why the last of the

*New York (Geneva) Station Bull. No. 359.

†L. C.

‡New York (Geneva) Station Bulletin No. 387.

four treatments cannot be combined with the regular blossom fall spraying for chewing insects and diseases. If such practice were adopted the tobacco probably should be used at the rate of 1 part to 600 parts of the spraying mixture.

Plant Lice.

(Aphididæ)

Although not nearly so abundant as last year various species have done enough harm to attract attention. The apple plant lice (particularly *Aphis mali* DeG.) have done much harm to foliage and fruit. Although reports received and observations made are rather meagre they agree that "Black-leaf 40" used with soap and water or with the ordinary spraying mixtures (Bordeaux and arsenate of lead or summer lime-sulphur and arsenate of lead) destroys the lice and does not injure the trees.

In this connection it should be said that Mr. Charles S. Beckwith, a senior student in Rutgers College, devoted a large part of his thesis time to an elementary study of the various combinations of nicotine solutions with common spraying mixtures for the purpose of determining whether the uniting seriously altered the physical make up of the combination or combined the nicotine in such a fashion as to make it ineffective. The results he obtained are set forth in a special section of this report.

Tests of standard tobacco extracts have gone far enough and have shown such results that persons having trouble with plant lice would do well to consider them as methods of control.

The wooly apple aphis (*Schizoneura lanigera* Hausm) appeared in unusual numbers and occasioned much complaint. It should be remembered that this insect lives both on the roots and on the upper parts of the tree, and that the elimination of the above-ground form contributes to the control of the below-ground form. Root treatments of orchard trees for destruction of lice have not proven very successful and it seems that elimination of the above-ground form by use of soap or nicotine and soapy sprays accompanied by proper pruning, cultivation and fertilization, is likely to give best results. In the nursery row, however, the elimination of the above-ground form may be profitably accompanied by a root treatment. Of the many that have been suggested at various times by various persons, it seems likely that running a liberal amount of tobacco dust in trenches along the rows, just over the roots will prove most satisfactory. The tobacco when carried by water down to the roots destroys the lice, acts as a repellant and is thought to have a fertilizing effect.

San Jose Scale.

(*Aspidiotus pericious* Comst.)

This species is not so frequently received in correspondence as are many of the older formerly-considered-less-troublesome kinds. It has been this year less frequently complained of than the oyster-shell scale. This is partly due to widespread knowledge of its recognition marks and methods of control, but also partly due to a great and widespread reduction in its malignity. It is obviously experiencing a period of depression. The writer does not believe, however, that spraying for it can safely be neglected.

Oyster-Shell Scale.

(*Lepidosaphes ulmi* Linn.)

This insect seems to be increasing in numbers and in amount of damage it does. This year, in addition to the usual trouble with it in nurseries and orchard plantings, it was found on birches growing in the woods at Westwood, New Jersey, and it was exceptionally abundant on poplar and black walnut at Somerville. On cultivated trees it is easily controlled by proper washes. Persons having trees infested with this scale should look after them carefully.

False Apple Red-Bug.

(*Lygidea mendax* Reut.)

This insect appeared in considerable numbers in various orchards about New Brunswick, but readily succumbed to treatment outlined in the 1913 report of the entomologist.

Potato Flea-Beetle.

(*Epitrix cucumeris* Harr.)

Without doubt this insect has been, during the past year from the standpoint of potato foliage injury, the most serious insect problem of the white-potato grower. During the entire season the writer did not see a patch free from injury. In most places the beetles were feeding on plantain and other weeds about the fields before the potatoes emerged from the soil. Scarcely were they above the ground before perforating the leaves began. This continued throughout the season. Between broods the damage was small. Even the second crop suffered much harm from this pest.

Rose Bug.

(*Macrodactylus subspinosus* Fab.)

The damage done by this species was sufficient to occasion complaint. Arsenate of lead and glucose again proved an efficient spray. The five pounds of lead arsenate in the usual formula was in some cases increased to eight.

June Bugs or May Beetles.

While the history of these insects shows instances of as great or greater abundance, the writer has never seen May beetles so numerous as they have been this year. Every warm quiet night during the season of their abundance (June) the trees on the writer's lawn were each a roaring swarm. Very generally over the state the tender leaves of forest, shade and fruit trees were eaten off. The injury occasioned much speculation as to the cause, and some complaint.

It seems likely that these beetles came from the white grubs that were so troublesome in the summer of 1912. That year it will be remembered the damage was so great as to cause it to be designated as the "White Grub Year."

Whether this extraordinary number of beetles foreshadows unusual damage by white grubs cannot at present be told. A careful watch will be kept and warning issued as soon as the danger can be definitely discerned.

Strawberry Weevil.

(*Anthonomus signatus* Say.)

This insect has this year done more harm than it usually does, and none of the measures tried thus far give promise of entirely satisfactory results. The growing of the staminate varieties as a trap does not appear to have had serious trial by our growers. Those to whom the writer has mentioned the possibility have found the suggestion totally new, or have decided that the disadvantages of the pistillate varieties are too great. Some aver that the berries from the pistillate varities are not equal in flavor to those grown from the perfect flower; others that the berries do not stand shipment as well.

Mr. J. L. Purzner in a letter dated May 14th called attention to the work of this insect at Cologne. The inspections which followed on May 20th showed in many instances a loss of 50 per cent. The variety known as "Manhattan" seemed especially susceptible. The injury was marked at Egg Harbor, Hammonton and Millville.

White Pine Weevil.

(*Pissodes strobi* Peck)

This insect has been much in evidence this season. Its work was noted at Bernardsville, South Orange, and Morris Plains. Adults were emerging on August 7th, when the detailed examinations were made.

Persons experiencing this trouble were advised to keep the terminal shoots sprayed during May and June with whale oil soap (1 pound to 6 gallons of water) to which one-half pound of arsenate of lead has been added. They were also warned to keep a sharp lookout for a slight yellowing of the tips and to examine promptly for signs of feeding. If punctures are found each should be probed with a soft wire to kill the larva. If the feeding has gone on to such an extent as to render recovery doubtful, the shoots should be promptly cut out and burned.

Hickory Bark Beetle.

(*Scolytus quadrispinosus* Say)

This insect has been just as injurious this year as last and is really a terrible pest of the hickory in the northeastern part of the state. It is a matter of great regret to the writer that his funds have not permitted him to take up the study of this species, for the present measures of control are not practical under the local conditions.

An Unusual Greenhouse Insect.

In a greenhouse in North Jersey a calandrid new to our collection was taken and sent to the Bureau of Entomology for identification. Mr. Schwarz determined it as *Eucactophagus graphipterus* Champion and remarked that it was a native of Costa Rica and the United States of Colombia. He further said there were only three specimens known.

Army Worm.

(*Leucania unipuncta* Harv.)

During May and early June reports of tremendous numbers of moths flying about the lights came from various cities throughout the state, the greatest interest being manifested by towns and cities along the coast from Sandy Hook to Atlantic City. The few specimens which we had a chance to examine were all army worm moths.

A little after the middle of June reports of army worm damage to corn, wheat and potatoes came in. In all cases the worms migrated from adjacent fields of grass. Early in July reports of extensive lawn injury by the same species began to arrive from nearly all parts of South Jersey. On July 17th the writer observed the worms at work in the lighthouse lawn at Atlantic City. They consumed all blue and other tender grasses, leaving the weeds and coarse grass. At that time they ranged from one-half an inch long to fully grown. The lawn was dry and brown, except in spots where coarse grass and weeds gave it a green color. Four days later complaints were pouring in from all parts of the state.

As is usually the case the rare parasitism visible at the beginning of the outbreak increased until almost all the worms that could be found were infested.

Arsenate of lead was sprayed on infested grass plots and killed many worms, but proved totally insufficient to stop an advancing horde. Poisoned bran mash likewise destroyed many, but could not stop the armies. In ditching across the line of march was found the successful method of stopping their progress. Ditches 12 to 20 inches deep with the smooth perpendicular side toward the field to be protected and furnished with six-to-eight-inch-deep post holes along their bottoms at distances of ten feet proved very efficient. The worms fell into the ditches, gathered in the holes, and were killed by pouring kerosene upon them or by crushing them with a flat-ending staff.

In North Arlington it was found that a hard roadway recently covered with the usual coating of road oil acted as a very efficient barrier, absolutely preventing the worms from crossing. Mr. Miller, finding this to be true, kept the road running between his place and the invading host covered with oil and practically none succeeded in crossing it.

The eggs seem to have been laid by the moths, probably the members of the flights mentioned earlier, in grasslands generally, including lawns. The larvæ fed upon the grass until the supply became exhausted, and then started out in search of food. Their night feeding habits prevented people from noticing them, and the work which they were doing was attributed to other agents. When, however, they began to migrate they were discovered at once and calls for help were sent in.

Persons, whose lawns and plants had been injured, were advised as follows: "If the worms have already turned the lawn reddish brown and have disappeared the injured grass should be liberally watered and fertilized in order that it may recover from the attack. For one acre of

medium-light to heavy soil a fertilizer* composed of 150 pounds of bone meal and 150 pounds of nitrate of soda should be satisfactory, while for the same sized plot of very light soil a fertilizer composed of 100 pounds of bone meal, 150 pounds of nitrate of soda and 50 pounds of muriate of potash should be used. The fertilizer should be applied just before a good rain, or be followed promptly by copious watering. It must be evenly distributed. Trees, bushes, and vines injured by this insect should be likewise furnished with food and water in order that they may recover from the attack."

In Monmouth County the Farm Demonstrator, Mr. W. B. Duryee, Jr., carried on a warfare against this pest and the report of his experience follows:

"The presence of army worms was first reported to this office on June 22nd, although they had been noticed in considerable numbers since June 18th. The area infested comprised perhaps 500 acres in the vicinity of Bailey's Corner, near Allenwood. The insects first appeared in the grass fields and in many cases were not noticed until the grass was cut when they made their way into other crops in search of food.

"The worms were also reported in numbers at East Freehold at about the same time (June 23rd). The crops damaged were grass intended for hay, potatoes, corn and wheat, the destruction of the last three not being severe owing to prompt measures of prevention. Four or five fields of timothy were rendered practically valueless, only the bare stalks being left."

The ditch method was adopted. A furrow was plowed across the worms' line of march. The loose soil which fell back into it after the plow passed was carefully cleaned out and the side toward the field to be protected was made smooth and perpendicular. "In these trenches holes were dug with a spade at intervals of twenty feet. These holes were cut eight or nine inches deep and as wide as the trench, with straight sides. The worms collected in these holes rapidly and to make their destruction doubly sure were sprayed with kerosene, which was very effective. In some cases the soil was so gravelly that it was impossible to make the side sheer enough to keep the worms from climbing out. In these cases a second trench, like the first, was made five or six feet in front of the first.

"It was found impossible to control the worms when feeding on plants. Arsenate of lead was fairly effective although slow in action; Paris green applied heavily enough to be effective burned the foliage. Kerosene emulsion was found useless at any dilution, because it injured foliage of corn when applied sufficiently concentrated to kill the worms. The worms were present in decreasing numbers for two weeks after they first appeared." It is probable that they were present for some time before the farmers saw evidence of their work.

*The formula is one devised by Dr. Jacob G. Lipman, Director of the Experiment Stations, at the request of the writer.

"The next serious outbreak was reported on July 16th. On investigation they were found to be very numerous along the coast from Sea Girt to Sea Bright, the infestation extending only a mile or two west. They were somewhat abundant at Red Bank and along the Rumson Road leading from Red Bank to Sea Bright. Isolated cases were reported as far west as Freehold. Lawns suffered principally from this attack, especially those that had been seeded during the last year or two."

Infested lawns were sprinkled or sprayed with arsenate of lead, poisoned bran mash was scattered, and air slaked lime and gasoline were employed. "The first was not very effective, seeming to operate merely as a repellant. The second was fairly effective in some cases, but not so in others because the worms refused to eat the bran when they could get grass. The third seemed most successful. Narrow depressions were made along the edge of walks, gardens, and buildings. The lawn was sprinkled with lime not allowing any to get into the trenches. The worms hid in these depressions during the morning to avoid the lime and by sprinkling them with gasoline great numbers were killed. Gasoline was better than kerosene as it did not stain the buildings or pavements and the odor disappeared. The worms menaced lawns in this section for ten days after they were first reported.

"The next report of damage was at Farmingdale on July 23rd. This was not serious and they soon disappeared.

"The number of parasitized specimens increased from rare instances, when the worms were first reported to almost 100 per cent. during the latter part of the infestation. The number of tachina flies increased correspondingly."

Apple-Tree Tent Caterpillars.

(*Malacosoma americana* Fabr.)

Late in April and early in May this species occasioned much complaint throughout the northeastern part of the state. Much of the land within reach of New York City is apparently held by speculators, and little effort is made by the owners to cultivate or even to preserve its decent appearance. Much of it is covered with scrub growth, including wild cherry bushes. Apple trees are found along fence rows and in old neglected orchards. This wild, uncared-for growth of cherry and apple became covered with webs of this insect. Allendale, Westwood, Hillsdale, Hillsdale Manor and Woodcliff Lake were among the towns worst infested. The species was mistaken for gypsy moth and newspaper reports of the occurrence of this insect were circulated.

The unusual number caused the foliage on these waste lands to become exhausted while yet many of the worms were only partly grown. Consequently apple, cherry and peach were defoliated and much garden truck consumed on places whose owners had used all possible care in destroying their own infestation.

Some evidence of the work of this species was found in South Jersey at Hammonton.

In limited localities this insect is readily controlled by cutting out the offending nests, or better still by spraying the foliage about the nest thoroughly with arsenate of lead (3 pounds) and water (50 gallons). When the outbreak covers a large territory and involves much growth on wild lands community action is advisable. In all such cases the aid of the entomologist should be sought and a well-planned campaign against the insect undertaken.

Florida Fern Caterpillar.

(*Eriopus floridensis* Guen.)

On September 18th this insect was found troublesome on ferns at Riverton. The firm on whose premises the injury was occurring had received some *Nephrolepis* from Florida, and it is probable that the species came with them. They were feeding on *Adiantum*, sp., *Cyrtomium* sp., *Blechnum* sp. and *Asparagus sprengeri*. *Blechnum* seemed to suffer most.

Argentine Ant.

(*Iridomyrmex humulis* Mayr.)

This species was taken in the packing from a case of nursery stock from Germany. Dr. W. M. Wheeler, who kindly determined the species, was at a loss to understand its occurrence in Germany, unless it was confined strictly to greenhouses. This suggested that perhaps the species was a member of the greenhouse-insect life of New Jersey. Systematic collections failed to show it, but did reveal three species new to the greenhouse fauna of the state. These were determined by Dr. Wheeler as *Tetramorium guineense* Fabr., *Prenolopis fulva* Mayr., and *Pheidole anastasii* Emery. All were taken at Rutherford, the first, April 9th, 1914, and the others on April 14th, 1914.

Fleas.

(*Ctenocephalus canis* Curt.)

The cat and dog flea occasioned a considerable amount of trouble in the houses of the well-to-do. In every case it was found in connection with pet cats or dogs. In some cases the fleas seemed to be breeding in the house after the animals had been denied access for a long time. In one instance the particular breeding place seemed to be behind a loose base-board in a bed room. Elimination of the pets as flea carriers by regular treatment with soap and water or pyrethrum followed by liberal treatment of all cracks and crevices in the infested rooms with gasoline will eventually relieve and prevent further difficulty. Proper treatment of the pets followed by thoroughly fumigating the infested rooms with hydrocyanic acid gas should give immediate and permanent relief.

Some of the persons troubled were convinced that the troublesome fleas were not cat and dog fleas but "sand fleas." Subjecting specimens to a careful microscopic examination resulted in every instance in showing them to be the cat and dog flea.

Grape Vine Potato-Gall.

This peculiar and interesting malformation was taken at West End and Rutherford. The casual agent is a small dipterous insect, *Lasioptera vitis* O. S.

Narcissus Fly.

(*Merodon equestris* L.)*

During October, 1913, this species was found by Miss Morlock, of Orange, working in the roots of her Iris. Although this is its first record in New Jersey it is recognized as a pest in British Columbia and in Europe. The infested plants were pulled up and destroyed.

Miscellaneous Species.

Among the arthropods doing noticeable but merely local injury may be mentioned the following species: (1) June 24th, millipeds feeding on potato plants at the base where the stems were in contact with moist soil; (2) July 10th, red spider injuring phlox at Red Bank; (3) July 13th, onions about Hightstown slightly injured by onion thrips (*Thrips tabaci* Linden); (4) July 6th, mealy hugs (probably *Pseudococcus trifolii* Forbes) attacking the base of Weigelia in F. & F. Nurseries at Springfield; (5) July 15th, currants on College Farm, New Brunswick, injured by the four-lined leaf-bug (*Pœcilocapsus lineatus* Fabr.); (6) July 7th, "Black Diamond" blackberries at Cologne injured by the bramble flea louse (*Trioza tripunctata* Fitch); (7) July 17th, elm trees in Somerville considerably injured by plant lice (probably *Callipterus ulmifolii* Monell); (8) June 15th, potatoes at Mullica Hill attacked by plant lice; (9) July 17th, euonymus at Somerville injured by the euonymus scale (*Chionaspis euonymi* Comst.); (10) July 6th, July 17th, catalpa at Hammonton and other South Jersey towns and at Somerville attacked by the catalpa sphinx caterpillar (*Ceratomia catalpæ* Bdv.); (11) July 17th, elm in Somerville injnred by wood leopard moth (*Zeuzera pyrina* Fab.); (12) June 26th, iris at Orange injured by *Macronoctua onusta* Grt.; (13) July 6th, scrub oak (*Quercus pumila*) in North and South Jersey woods injured by the common oak caterpillar (*Anisota senatoria* Abb & Sm.); (14) July 7th, the blackberry plants at Cologne injured by the blackberry crown borer (*Bembecia marginata* Harr.); (15) July 8th, pussy willow in Hammonton injured by the poplar borer (*Saperda calcarata* Say); (16) June 24th, cucumbers and melons in Monmouth County injured by the striped cucumber heetle (*Diabrotica vittata* Fab.); May 18th, asparagus at Greenwich injured by asparagus beetle (*Crioceris asparagi* Linn.); (18) July 30th, tomatoes at Centre Square attacked by Colorado potato beetles (*Leptinotarsa decemlineata* Say); (19) June 8th, maple at Passaic injured by petiole miner, a saw fly (*Priophorus acericaulis* McG.).

Another Method of Rearing Silk Worms.

Mr. Elias Mead of Passaic, N. J., approached the entomologist with a plan for testing a better method of rearing silk worms. Mr. Mead

*Determined by Nathan Banks through kindness of Dr. L. O. Howard.

would like to have selected some mulberry trees at New Brunswick and carried on the test close to the entomologist's office. The lack of mulberry trees prevented this, however, and Mr. Mead then made the test in his own yard at Passaic, the entomologist or his representative visiting the scene of operations at intervals. Mr. Mead explained that the method had been devised by his son, Mr. M. H. Mead, and that its particular merit lay in the high percentage that came to maturity and the unusually low labor cost involved in caring for them.

Accordingly on June 11th, Mr. H. B. Weiss visited Mr. Mead's home and witnessed the placing of two colonies of caterpillars on a small mulberry tree. The method involved the following operations: (1) slipping an elongated, double-walled and blind-ending cloth sack over several leafy branches; (2) introducing the caterpillars at open end; (3) replacing the cage and contents on fresh food if the amount of foliage enclosed proved too small; (4) removal of the cage after pupation and harvesting of the cocoons.

In the cages under observation, the food was sufficient and no change was made during the course of the experiment. On July 10th, Mr. Weiss examined the two cages and found the caterpillars practically full grown and the foliage almost consumed. On July 18th, Mr. Weiss again saw the cages and found that all caterpillars had pupated. On July 21st, the entomologist examined and removed the cages with the following results. The first cage started with 65 caterpillars and produced 57 good cocoons. The second cage started with 55 caterpillars and produced 47 cocoons.

At Mr. Mead's request the writer removed two other cages, neither of which we had had under observation. In one according to Mr. M. H. Mead, 56 caterpillars had been placed. In the other 55 had been placed. In the first 55 cocoons were found, one of which was weak. In the second 50 cocoons were found.

INSECT COLLECTIONS.

Increase.

The insect collection has been increased by the addition of some *Coleoptera* from Mr. C. A. Frost and by the addition of a collection of California *Coccidæ*.

Exhibition.

An exhibition collection of injurious insect species has been started. The specimens are placed in Riker mounts, because of the ease and safety with which this form of collection can be transported. The following mounts have been prepared: 2 cases of California scales, 3 cases showing different types of insect injury to leaves, 2 cases of New Jersey scales, 2 cases showing insect injury to stored products, 3 cases showing some of the galls of New Jersey, 1 case of Cicadidæ, 1 case of pear psylla, 1 case of pear leaf blister mite, 1 case of potato

stalk borer, 1 case of elm leaf-beetle, 1 case of rose chafer, 2 cases of *insect work in bark layers.*

Anti-Peach-Borer Coatings.

The work this year has been devoted to a general test of hard asphaltum, soft asphaltum, air slaked lime, "government whitewash," "Boro-wax," sulfocide, etc., as outlined in last year's report. All substances *failed to obtain complete control.* The *soft asphaltum* gave the most encouraging results, because it withstood the weather for a full season and allowed borers to penetrate only below its lower edge. All other coatings showed borers just above or were penetrated by them. One full year of trial has shown no asphaltum injury *to any age of trees. Further experiments looking toward the effecting of a sufficiently complete coating with this and other similar* substances will be made.

COMBINATIONS OF NICOTINE WITH ORDINARY SPRAYING MIXTURE

At various times in the past several years the combination of nicotine preparations with summer strengths lime-sulphur and arsenate of lead or with bordeaux and arsenate of lead has been recommended. In no case, however, does the recommendation seemed to have been based on extensive studies. Among New Jersey fruit growers, a few have used "Black-leaf 40" combined with Pyrox, but the state of *mind is apparently one of indecision.*

Complaints from more or less reputable sources have indicated that the combination may result in forming a mass of troublesome precipitate. It was decided therefore in connection with a study of the false apple red bug and its control to determine in a laboratory way whether a *combination of nicotine solution with the ordinary* spraying mixtures produced any undesirable change which could be readily detected. Mr. Charles S. Beckwith, a senior student, who had chosen as his thesis the study of the false apple red bug and its control undertook this investigation and his statement of procedure and results follows herewith.

"An investigation into the effect of combining nicotine with the common spraying mixtures for our purpose seemed naturally to divide itself into two phases—*effect on the spray mixture* and *effect on the nicotine.* By force of circumstances investigation of the first phase was limited to the amount of precipitate that is formed, while the second dealt with the ability of the nicotine to stay in solution and therefore to retain its effectiveness.

Material Used.

"'Black-leaf 40' is perhaps the most widely tested of the standard strength nicotine preparations and 'Nikotiana' is a new product made at

Madison, New Jersey, by the Aphine Manufacturing Company. Both of these were used in the experiments, the former being diluted one part to 600 parts water and the latter at the rate of one part to 180 parts water.

"The action of nicotine was tested with the following mixtures: Lead arsenate; zinc arsenite; Bordeaux mixture; lime sulphur; Bordeaux mixture and lead arsenate; Bordeaux mixture and zinc arsenite; lime sulphur and lead arsenate; lime sulphur and zinc arsenite; 'Pryox'; 'Electro Bordo-lead.'

Laboratory Methods.

"All mixtures were made up in the same proportions as in common orchard practice, using distilled water. The nicotine was added to the solution in the proportion given above. All liquid measurements of 50 cc. or less were made with a pipette. The solution was carefully mixed and 100 cubic centimeters were passed through a Gooch filter. The precipitate was washed once with cold water and then dried at the temperature of 100° c. for four hours. It was then cooled and weighed.

"The filtrate was tested for nicotine by adding a solution of iodine and potassium iodide, which gives a red precipitate in the presence of nicotine. When there was lime sulphur in the mixture the nicotine was distilled by a steam distillation process and the distillate tested for nicotine.

Effect on Spray Mixtures.

"The effect of the nicotine preparations upon the other ingredients in the mixture was studied and the precipitate from 100 cubic centimeters of mixture was weighed.

Table Showing the Amount and the Difference in Weight of the Precipitate n 100cc of Spray Mixture With and Without Adding Nicotine Preparation s.

KIND OF MIXTURE.	Amount of ppt. in grams when no nicotine is added			Amount of ppt. in grams when "Black-leaf 40" is added.			Difference on addition of "Black-leaf 40."	Amount of ppt. in grams when "Nikotiana" is added			Difference on addition of "Nikotiana"
	1st.	2nd.	Aver.	1st	2nd.	Aver.		1st	2nd.	Aver.	
Lead arsenate.	.61	.60	605	57	.57	.570	- .03	.65	.62	.630	.03
Zinc arsenite.	.23	.21	220	21	.20	205	- 015	23	22	225	005
Bordeaux mixture.	.88	.86	870	90	87	885	+ .015	89	90	895	+ 025
Lime sulphur.	00	00	.000	01	01	010	+ 01	00	00	.000	0
Bordeaux mixture and lead arsenate.	.70	.70	700	72	.72	.720	+ 02	76	74	.750	+ .05
Bordeaux mixture and zinc arsenite	.46	.46	.460	.45	46	455	- 005	49	47	480	+ 02
Lime sulphur and lead arsenate.	.65	.63	.640	67	67	670	- 015	.67	62	645	- .005
Lime sulphur and zinc arsenite.	.30	.30	.300	27	30	.285	- 03	30	29	295	- 005
Pyrox.	.50	51	.505	49	48	.485	- .01	49	49	490	- 015
"Electro" Bordo-lead	66	.65	655	.74	72	.730	+ 075	75	74	745	+ 09

"In no case does the nicotine make any marked change in the amount of precipitate. The small variations may be due to a number of causes but they are not large enough in any case to affect the usefulness of the mixture.

Effect on Nicotine.

"The filtrate from all the nicotine spray mixtures gave a red precipitate when a mixture of iodine and potassium iodide was added. This proves that the nicotine remained in solution as nicotine or nicotine sulphate. It is effective in either case. Even the very strong lime sulphur solutions failed to break up the nicotine or combine with it in an unsatisfactory way.

"In order to determine the effectiveness of the nicotine when combined with other substances, observations were taken in two orchards infested with the false apple red bug. One was on the College Farm in New Brunswick, the other was on the farm of Mr. J. A. Cortelyou at Princeton. On the former, a mixture of lime sulphur, lead arsenate and 'Black-leaf 40' was used and on the latter, lead arsenate and 'Black-leaf 40.' No more care than usual was taken in the sprayng of the trees, the only difference being in the addition of the nicotine. In both cases, the infestation was wiped out so that a half hour search failed to reveal a single nymph whereas, before the spraying, nymphs in the first and second stages were numerous. A second search a week later failed to reveal any nymphs or any of their characteristic work.

Conclusion.

"It is evident that the two nicotine preparations, 'Black-leaf 40' and 'Nikotiana,' can be mixed with the common spray mixtures without a serious precipitate forming and without any apparent detriment to the nicotine."

Potato Spraying and Dusting.

This second year of potato spraying and dusting has seen the scope of the work greatly increased. Instead of one field, three, each located in a typical potato growing section of the State have been used. Instead of eleven acres sixty acres have been involved. Instead of one variety, three have been tested. As stated in our previous report the purpose of this work is: (1) to determine in a large practical way the relative value of spraying and dusting mixtures in getting a maximum yield of tubers through control of injurious insects and plant diseases and through growth stimulus imparted to vines; (2) to devise a satisfactory method of controlling the potato flea beetle (*Epitrix cucumeris* Harr).

This work was carried forward as a co-operation between the Experiment Station and the potato growers concerned on the one hand and the Experiment Station and certain commercial concerns on the other. The Experiment Station directed and assisted in making

the applications and made the necessary observations on the results. The potato growers, Mr. J. Harry Kandle, of Elmer, Mr. Frank P. Jones, of Freehold, and Mr. Robert M. Dilatush, of Robbinsville, made the applications and in some cases helped in taking the data on yields.

The principal group of commercial concerns co-operating were headed by Mr. F. H. Pough, of the Union Sulphur Company. With Mr. Pough, were associated representatives of the Corona Chemical Company and the Dust Sprayer Manufacturing Company. Mr. Charles Carpender, of the Vreeland Chemical Company, associated with representatives of the Bateman Manufacturing Company, co-operated with the Station in its work in Robbinsville. The Thomsen Chemical Company co-operated with the Station in its Robhinsville work, the Anshacher Insecticide Company in its work at Freehold and the Kil-tone Company in its work at Elmer.

The Union Sulphur Company furnished the sulphur and made up all the dust mixtures; the Corona Chemical Company furnished the arsenate of lead; the Dust Sprayer Manufacturing Company, the dusting machines; the Vreeland Chemical Company, the Bordo-lead; the Bateman Manufacturing Company a potato sprayer for work at Robbinsville; the Thomsen Chemical Company the arsenite of zinc; the Ansbacher Insecticide Company the Bordeaux-lead, used at Freehold; the Kil-tone Company the Kil-tone, used at Elmer.

In return for this aid from commercial concerns, the Station obligated itself to arrange for and carry out the test, and to furnish a statement of results. It was further, distinctly understood that, while any of the co-operating concerns might use the facts discovered for planning future work, no use was to be made of it for publicity purposes until the results had been printed by the Experiment Station.

In this co-operation the Experiment Station was represented by its departments of Plant Pathology and Entomology. Owing to the fact that the problems of protecting potato foliage from parasitic injury seemed to be mainly entomological, the Department of Entomology assumed complete charge of carrying out the plans that were made in conference. Mr. Alfred E. Cameron, a scholar of the Board of Agriculture of England, who at the time when this work began was studying with the entomologist, was given charge of it, and his report of the investigation follows herewith.

"Potato Spraying and Dusting Experiments for the Year 1914.

BY

ALFRED E. CAMERON, M. A., M. Sc.,
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Introduction.

"I have had the pleasure of deriving from many farmers, well versed in the most up-to-date methods of agriculture, their personal experiences in the matter of spraying. Although in a few cases there was a certain chariness in expressing an opinion, the general trend of their ideas has been hitherto essentially antagonistic to the adoption of spraying with Bordeaux, in the first place as entailing more trouble than it was thought to be worth and in the second place as failing to prove of any advantage when the final profits came to be reckoned up. This seemed more than interesting to me in view of what was the experience of others, both in other states of this country and in other countries of the world, and I finally concluded that either some climatic or soil factor or perhaps some method of agriculture counteracted or obscured the otherwise admittedly beneficial effect of the application, or that there was a slipshodness or carelessness in the manner of its preparation and treatment.

"Three places were secured for the accomplishment of the work, namely, at Freehold, Robbinsville and Elmer, in the counties of Monmouth, Mercer and Salem, respectively, districts which may be considered fairly representative of the potato growing sections of the State, and at all three places satisfactory returns showed the benefits to be obtained from the employment of Bordeaux. At Freehold, however, the increase in yield as compared with the other treatments, hereafter discussed, was not marked. Indeed, so little was the difference in any of the treatments and so uniform the yield that I am inclined to look for the reason of apparent failure here in the fact that peculiar methods of culture may influence the final result. Here the surface soil is a sandy loam—Collington sandy loam containing a large amount of potash (2.5 per cent.)—underlaid by a greenish-yellow, sticky marl, and on this particular farm a system of deep-ploughing enriching the top soil has been adopted with the most satisfactory results. Added to this we have to meet the fact that our co-operator is in the habit of feeding his soil with abundant supplies of barnyard manure as well as commercial fertilizer, which may secure such strong and vigorous plants that the Bordeaux-effect is entirely lost. In other words, what I would tentatively suggest in view of the evidence obtained is that under certain conditions, with which we are as yet not entirely familiar, the potato vines may arrive at an optimum of vigor beyond which they may fail to be stimulated, a critcal point in fact. At Freehold

then the slightly increased yields on the Bordeaux as compared with those obtained on the sulphur and proprietary Bordeaux plots may be justly ascribed to its more efficient control of the flea beetle (*Epitrix cucumeris* Harr.) which in dry seasons like that just past levies in New Jersey at least a higher tax on the crop than any of its vegetable parasites. Indeed here we have a reason for the comparatively poor showing of Bordeaux in New Jersey. One dry season follows another with such regularity that the early (*Macrosporium Solani* E. & M.) and Late Blights (*Phytophthora infestans* De Bary), exacting such a toll in the more northern states, here in only odd humid seasons favorable to the germination of the spores of the latter, get the opportunity to exert their ruinous influence. Therefore it is only natural to assume that Bordeaux, which is specific against these potato blights, will be more likely to demonstrate its capabilities in seasons favorable, to the generation of blights, and this indeed has been the experience of several New Jersey farmers.

"The use of sulphur in these experiments marks an innovation in the application of this material as a fungicide of potato leaf diseases in this state at least. In Europe, especially Southern France, and in Northern Africa, in Algeria, sulphur has been extensively used in combatting the odium and other fungous diseases of the grape vine with most encouraging results. According to Bourcart*, sulphur has also a direct action on the grape vine which it renders more vigorous. That this is probably true also of the potato vine under certain circumstances is shown by the results obtained at Elmer on blocks dusted with a mixture of sulphur and lead arsenate. These yielded 21 bushels per acre more potatoes than those treated with arsenate of lead alone. This was, however, but a third of the increase derived from the use of Bordeaux lead arsenate mixture.

"A series of experiments carried out by Bourcart† showed that sulphur virtue of the supposed generation of the sulphur dioxide or sulphuretted hydrogen, but by reason of its own vapours.

"The comparative aspect which this year's experiments are intended to bear out must not be lost sight of and the differences in yields obtained on the differently treated plots are worthy of strict attention. Besides the fact that the home-made Bordeaux mixure gave the best return as regards yields in all three experiments, it also proved to be the most economical in application, excepting, of course, the lead arsenate used on the check plots at Freehold and Elmer and intended only to check the ravages of the Colorado potato and flea beetles.

"The experiments at Geneva have also come to the conclusion that there are several factors which might have an important influence on the results, amongst which are mentioned differences of locality and soils.‡ The averages for the ten-year experiments at Geneva and Riverhead reveal the fact that the average increase for sprayed potatoes per acre at the former is

*Insecticides, Fungicides and Weed Killers—E. Bourcart, London, 1913, p. 46.

†Loc. Cit. p. 46.

more than double the increase for the latter. At Geneva the soil is rather a heavy clay loam, at Riverhead a sandy loam, interesting in view of what has been said about the experiments at Freehold, New Jersey. Sheltered rather than exposed conditions give better results and in the final reckoning up the fertility of the land and the variety of the potato are factors of no mean importance. But, probably as the author remarks, most attention must be paid to thoroughness in spraying.

Plan of the Experiments and Arrangements of Plots.

"The idea was to carry out the experiments on as large a scale as possible so that the objection which is often advanced, of the futility of forming correct conclusions from the yields of rows treated singly would not hold good. Therefore at Robbinsville and Elmer the fields were divided up into plots of 20 rows and six of these plots formed a series. Within the series each alternate plot was a check treated at Robbinsville with a mixture of zinc arsenite and gypsum calculated to repress the activities of the flea beetle and Colorado beetle, and at Elmer to this same end, arsenate of lead was employed. The other treatments in the block or series varied: at Elmer, Bordeaux Mixture combined with arsenate of lead, Kiltone, and a mixture of sulphur and lead arsenate; at Robbinsville, Bordeaux combined with lead arsenate, Vreeland's "Electro" Bordo-Lead, and a mixture of sulphur and zinc arsenite. At Robbinsville where the field contained slightly more than twenty-four acres this series of plots was repeated four times, so that any inconsistancies, due to the nature of the soil, might be eliminated as far as possible. At Elmer where there was approximately ten acres, there was only space for a single repeat.

"The arrangement at Freehold was slightly different, the field of about twenty-four acres being divided up into blocks of but eight rows so that many more check plots could be inserted. Then again every alternate plot was a check, the other plots in the series of six being treated with Bordeaux mixture and lead arsenate, a mixture of sulphur, lead arsenate and gypsum, and Ansbacher's Bordeaux. It will be noted that at each place a different proprietary spraying mixture was used.

Methods of Experiments.

"In applying the wet preparations, two types of spraying machines were employed. At Elmer, the Watson Sprayer, made by the Field Force Pump Company of Elmira, N. Y., gave eminently satisfactory results. The only objection that could be made was the fluctuation in the maintenance of the pressure from sixty to eighty pounds. It is desirable to aim at getting a higher pressure than this so that the spray-liquid may be delivered as a fine mist on the leaves. At Freehold and Robbinsville the power spraying machine made by the Bateman Manufacturing Company, of Grenloch, N. J., gave the requisite pressure of 100 pounds, ensuring a uniform application of the fluid. In all cases the nozzles were adjusted so that four rows could be covered at one time, and these machines all gave the 'diamond' effect in their delivery of the spray, a fact of the utmost importance, seeing that it is necessary to cover the under as well as the upper surfaces of the leaves with the mixture.

"In applying the dust mixtures of sulphur combined with gypsum, arsenite of zinc and arsenate of lead, the Potato Duster made by the Dust Sprayer Manufacturing Company, of Kansas City, Mo., was used. Here it is necessary to state that the original plan was not carried out in its entirety and whereas it was intended to apply the lead arsenate to the checks as a dry powder, so much difficulty was experienced that eventually it was decided at Elmer and Freehold to apply it wet at the rate of six pounds per 100 gallons.

"In all cases the application of the sulphur mixtures was successfully undertaken, except at Freehold, where no treatment was made for the first spraying, and for the second a mixture of hydrated lime and lead arsenate was used in dry form in the proportion of sixty-nine pounds of the former to thirty-one pounds of the latter.

"Comment must be made on the fact that the potato dusting machine did not give complete satisfaction, but a certain amount of blame must also be addicted to the materials which frequently cohered to such an extent within the delivery pipes that mechanical blocking ensued. It was on account of this reason mainly that the lead arsenate was applied wet, otherwise a great deal of valuable time would have been wasted.

"Even as it was a lot of trouble was experienced in regnlating the quantity of dust that was being applied, but finally, after making some adjustments, we were enabled to feed out the sulphur-gypsum-lead-arsenate, the sulphur-zinc-arsenite and the sulphur-lead-arsenate mixtures in the required amounts of about 30-36 ponnds per acre.

"Most up-to-date farmers who find it necessary to use Bordeaux mixture are acquainted with its method of preparation, so that it seems superfluous to repeat what is a very old story here. Suffice it to say that the formula of the mixture employed in our experiments was the same in all three, namely, 5-5-50, and to every 100 gallons of the mixture six pounds of arsenate of lead were added as a poison for the Colorado potato-beetle (*Leptinotarsa decemlineata* Say) and the flea beetle (*Epitrix Cucumeris* Harr.). This same poison served to control the ravages of these pests at Elmer and Freehold. but at Robbinsville zinc arsenite was tried, with what results will be hereafter set forth in the section of flea beetle control.

"In the case of the proprietary Bordeaux preparations, Anshacher's was applied at the rate of 20 pounds per 100 gallons, which sufficed to cover just about two acres. Vreeland's Electro Bordo-Lead was applied at the rate of about 18 pounds per acre suspended in 100 gallons, an intentionally rather heavy application, while 13 pounds of Kil-Tone, of which 18 pounds were suspended in 100 gallons, served to treat one acre at Elmer.

"It was so arranged that an interval of 8 to 12 days should elapse between each treatment, this being considered the outside limit for safety, since the new shoots which are springing up ran serious risk of damage both from insect destroyers and fungous parasites if a longer period was allowed to intervene between the applications. Assiduous attention to spraying and thoroughness of application are important factors for good results, and it has been shown by the experiments of the New York Agri-

cultural Experiment Station* that the more sprayings one makes the greater are likely to be the yields, and therefore the profits. In New Jersey, the vines begin to overlap in the rows about the end of June, making it difficult for the operator to drive a team into the field without inflicting mechanical injury to the vines. It is quite possible to have made four applications previous to this, but the vines continue to grow on for a month later. In cases where circumstances are favorable to the appearance of the late blight, it would be absolutely essential to make at least two further treatments before the vines die.

"The scheme of the treatments was as follows, the locality appearing first, then the dates of the four applications, then the four treatments:

"Elmer, May 21-22, June 1-2, June 10-11, June 24-25; Bordeaux-Lead-Arsenate, Kil-Tone, Sulphur-Lead-Arsenate 5-.5, Lead Arsenate.

"Freehold, May 21-22, June 5-6, June 16-17, June 27-28; Bordeaux-Lead-Arsenate, Ansbacher's-Bordeaux-Lead, Sulphur-Gypsum-Lead-Arsenate (2-3-1), Lead Arsenate.

"Robbinsville, May 27-28, June 10-11, June 23-25, June 30†, July 1; Bordeaux-Lead-Arsenate, Vreeland's "Electro" Bordo-Lead, Sulphur-Zinc-Arsenite (5-1), Gypsum-Zinc-Arsenite (5-1).

DISCUSSION OF THE INDIVIDUAL EXPERIMENTS.

AT ELMER.

"From the middle of May until the middle of August there were eleven inches of rainfall with periods of prolonged drought during which there was quite a lot of tip-burn, a physiological condition of the leaves for which no proper reason can be assigned. Probably it is a case of the plant suffering from mal-nutrition activated by some climatic or atmospheric condition. We cannot say that drought is the only cause because it has been observed to be prevalent during wet spells. On that date, May 27, when the first treatment was made, the flea-beetle had already been at work for several days, although the vines were not more than six inches high. The damage being done was considerable, and added to this there were large numbers of eggs of the Colorado beetle, some of which had already hatched, betokening injury to come.

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*Bull. 323 N. Y. Agri. Exper. Sta., Geneva, p. 323, 1910.

†On this date an application of Sulphur-Zinc-Arsenite was made on the sulphur plots of the first and second series—there being four series in all at Robbinsville—and on sixteen rows of the third series when an accident rendered the machine useless and so no further spraying was done. At Robbinsville, therefore, with the exception of these plots mentioned, only three applications of the various treatments were made.

The plan of the field was as follows:

Plan 1.—The Experiment at Elmer.

Series I	*Bordeaux Mixture and Arsenate of Lead*
	Arsenate of Lead.
	Kil-Tone.
	Arsenate of Lead.
	Sulphur and Lead Arsenate Mixture.
	Arsenate of Load.
Series II	Kil-Tone.
	Arsenate of Lead.
	Bordeaux Mixture with Arsenate of Lead.
	Arsenate of Lead.
	Sulphur and Lead Arsenate Mixture.

"The field was divided into two blocks in one of which there were six plots of twenty rows each, in the other five, each plot measuring 0.89 acre except the last Arsenate of Lead plot, which had only fifteen rows and measured 0.68 acre.

"On June 2nd, the field was examined for flea-beetle. The numbers had been greatly reduced, and, curious to relate, an adjacent field of potatoes which had not been treated, was badly infested with this small pest. It would appear that it had been repelled to this neighboring field. On some of the vines a few aphides *Rhopalosiphum solani* Thos., were observed at work, but not in sufficiently great numbers to cause uneasiness or to make it worth while to go to the expense and trouble of a special treatment. At this stage the Kil-Tone plots compared favorably with the others as regards insect control and indeed, so far as observations could be trusted, this proprietary preparation seemed to give qnite satisfactory results.

"On June 24th a rather curious phenomenon was observed. The potato plants were now in blossom, bnt the flowers had died off quickly on all the plots except on the checks sprayed with Arsenate of Lead. What was the exact significance of this cannot be stated, but that there was no ultimate detrimental effect is shown by the yields, which were greater on the plots than on the controls. On this date, too, there was a slightly traceable recrudescence of the flea-beetle, especially noticeable on the sulphur

plots, but after the treatmnt had been made they were effectively repelled. Perhaps the reason for their greater number on these plots was the fact that the dust does not adhere to the vines for such a long time as the wet sprays, and therefore more freqnent applications would have to be made to maintain its efficiency.

"On July 7th, in addition to *Epitrix cucumeris* Harr. there was present in appreciable numbers another species of the flea-beetle, *Epitrix fuscula* Cr., which, according to the late Dr. Smith, is supposed to be rarely found in New Jersey. The recurrence of the flea-beetle at this period led me to the belief that there is a second brood, if not a third, in this State, for after a decided diminution a second time there was an increase on August 26th on the late crops in the southern regions. These periods of great infestation alternated with periods of absence of attack are generally characteristic of multi-brooded species.

"As regards fungous diseases, cases of early blight were very rare on the first crop, and late blight was not observed, but on the second crop in Angust, early blight seemed to be rather general, appearing first when the plants were yet small.

"During the early days of August the old-fashioned potato beetle, *Epicauta vittata* Fab. appeared suddenly in the fields of South Jersey, stripping the vines of all leaves that were yet green. This was considered peculiar in view of the fact that not a single specimen was met with in the northern parts of the State. Its occurence in the south can be associated with the greater prevalence of grasshoppers, on the eggs of which the meloid beetle thrives in its larval stages. It is a commonly cited example of an insect which undergoes a hypermetamorphosis from an incipient active predaceous larva hunting for its food voraciously, to a sluggish grub stage. This marked change in habit is induced by its latterly finding ample provender in the grasshopper burrow dug for the reception of the eggs, without having to be energetic in satisfying its appetite.

"Throughout the season the plots sprayed with Bordeaux mixture gave every promise of large yields, as the vines had a healthy deep green color while they retained their vigor at the end of the season for almost ten days longer than those in the other plots. From an examination made July 24th, the order of value of the various treatments was as follows: (1) Bordeaux Mixture and Arsenate of Lead; (2) Sulphur and Lead Arsenate Mixture; (3) Kil-Tone; (4) Lead Arsenate.

"That this order as judged from the vines had some significance can be judged from the yields as obtained when the potatoes were dug on August 10th.

Yield From Plots Sprayed Experimentally.

Table I.—Elmer. Var. Cobbler.

Nature of Application.	Yields in bu. per acre		Average of the two plots.
	Series I.	Series II.	
Bordeaux-Lead-Arsenate	252 85 133.25	298 35 239.1	275 6
Lead Arsenate-Check.	222.7 189 4	235.25 256 65	212.725
Sulphur-Lead-Arsenate (5-.5).	222 1	245 0	233.5
Kil-Tone.	200 2	228 8	214 5

Average gain in bu. per acre of Bordeaux over check plots.	62.875
Average gain in bu. per acre of Bordeaux over Sulphur plots	42 1
Average gain in bu. per acre of Bordeaux over Kil-Tone plots.	61 1
Gain in bushels per acre of Sulphur-Lead-Arsenate plots over check plots.	20.775
Gain in bushels per acre of Sulphur-Lead-Arsenate plots over Kil-Tone	19.00

"Two years previously the same field had been planted in potatoes. Then followed a rotation of grass, clover and timothy, which was mowed in the summer following for hay. Late in the fall it underwent ploughing, the soil being turned up to a depth of eight inches, and then in the spring worked with a Clark cut-away harrow. Fertilizer of the formula 4-8-10 was administered at the time of seed-planting at the rate of about a ton and a quarter to the acre.

AT FREEHOLD.

"From June 21st until the end of July, representing the most important period of growth of the vines, there was only 4.8 inches of rain, and although the weather was excessively dry and warm at times the plants made such headway that the profuse vines of the Giant variety were meeting in rows almost at the time of the fourth treatment on June 16th. Here there was a fair amount of tip-burn, and also some *Fusarium oxysporum*, the fungus of dry rot. There was no late blight and only an infinitesimal amount of early blight, which appeared first late in the season, about July 20th. Practically none was to be found on the plots sprayed with Bordeaux mixture or with the Ansbacher preparation, but the Lead Arsenate and Sulphur dust plots had quite a little. However, not a great deal of damage was committed as the vines were already dying.

"As has already been said, there were eight series of six plots at Freehold, with a smaller series, IX, of but two plots. The area of the field was 24.57 acres and each plot had but eight rows. At no time throughout the season could the eye observe any difference in the vines of the various plots that could be supposed to be due to difference of treatment, and as the probable reasons for this remarkable fact have already been detailed it will not be necessary to take up the discussion again at this point.

"The same phenomenal fluctuation in the presence of the flea-beetle was likewise observed here as at Elmer and also at Robbinsville lending further support to my belief of there being three broods of this pest in New Jersey. Johannsen* is quite emphatic in his assertion that there is

*Bull. 211, Maine Agr. Exper. Sta. Potato Flea-Beetle, 1913, pp. 39-40. O. A. Johannsen.

but a single brood in Maine, or at least a partial second, and quotes Sirrine's experience in New York as supporting his statement. This, however, does not argue that single-broodedness is an inseparable and universal characteristic of the species.

"The yields as obtained at Freehold are set forth in the table, and a glance at the last column will readily show how little advantage there was in spraying or dusting. Still something was achieved in that the home-made Bordeaux mixture vindicated itself, if ever so little, here as at Elmer, but on this occasion the Lead Arsenate check plots came out somewhat ahead of the proprietary Ansbacher Preparation. Perhaps the results would have worked out somewhat differently had it been possible to apply the *Sulphur-Gypsum-Lead-Arsenate* in a more satisfactory fashion for the non-application of this material during the first and second treatments also militated against a true comparison of the results.

"At Freehold the variety most grown is the "Giant" and the tubers are sold mixed, there being no separation into firsts and seconds, or marketable and culls.

Freehold.—Yield from Plots Experimentally.

Table III.*

Nature of Application.	YIELD IN BUSHELS PER ACRE.									
	Series I.	Series II.	Series III.	Series IV.	Series V	Series VI.	Series VII.	Series VIII.	Series IX	Avg. of the nine plots
Bordeaux-Lead-Arsenate	309 4	279 2	287 2	291 4	279 9	288 75	285	279 59	274 16	286 06
	275 0	291 6	272 1	310.88	275 0	288 75	284 16	275 0	275 0	....
Lead Arsenate Check	324 0	290 7	281.7	292 1	275 0	284 16	288 75	265 8	.	283 38
	275 0	286 8	293 7	280 5	275 0	279 58	288 75	265.8	. .	. . . .
Sulphur-Gypsum-Lead-Arsenate	303.4	291 1	275 0	290 8	265 5	270 14	252 08	252.08	.....	275 01
Ansbacher's Bordeaux Lead	286 8	290 2	294 1	286 7	286 7	279 58	265 8	265 8		281.96

*Table II. has been omitted.

"It is of interest to note the general uniformity of the figures, there being very little variation in yield in the plots of each individual series, except perhaps in series I, where the Bordeaux plot out-yielded the average of the check plots by 18 bushels per acre. In this series, too, the Sulphur-Gypsum-Lead-Arsenate plot also gave an increase of twelve bushels per acre over the check plots, while the plot sprayed with Ansbacher's Bordeaux-Lead lagged behind the check plots to the extent of 4.5 bushels. But this only serves to show how little confidence can be placed in the results when the figures of only a single series are considered. The truth can only be ascertained by averaging up two or more series, indeed, the greater number of series the more certainly can we arrive at a general conclusion.

"The field at Freehold, as regards previous cultivation, presented three distinct sections. Six acres had been planted in potatoes for four years, and each year wheat and crimson clover had been ploughed under as a green manure. Nine acres had been planted with corn during the two previous years and cow-peas sown out amongst the corn. Here there had been a rotation of wheat, clover and timothy, and corn. The remaining nine acres had borne a potato crop continuously for six or seven years, and on this particular section a system of deep ploughing had been practiced. It has already been mentioned how radical cultivation of this type might obscure the effects of spraying.

AT ROBBINSVILLE.

"On the whole the weather was very dry in this district of the State during the summer, but frequent showers helped to bring the rainfall up to about ten inches, extending over a period of about three months from May 27th, when spraying started, until the potatoes were dug. Shortly after the first treatment was made there were neither many flea-beetles nor Colorado beetles to be seen, although in all conscience the infestation was quite severe on other fields planted with early Cobbler seed. The variety here treated was the "Green Mountain."

"The plan of the plots on the field of 24.57 acres is outlined in the following scheme:

Plan III—The Experiment at Robbinsville.*

Series I	Bordeaux Mixture and Lead Arsenate
	Zinc-Arsenite-Gypsum.
	Sulphur-Zinc-Arsenite.
	Zinc-Arsenite-Gypsum
	Electro Bordo-Lead.
	Zinc-Arsenite-Gypsum
Series II.	Sulphur-Zinc-Arsenite.
	Zinc-Arsenite-Gypsum.
	Electro Bordo-Lead.
	Zinc-Arsenite-Gypsum.
	Bordeaux Mixture and Lead Arsenate.
	Zinc-Arsenite-Gypsum.
Series III.	Sulphur-Zinc-Arsenite.
	Zinc-Arsenite-Gypsum.
	Electro Bordo-Lead.
	Zinc-Arsenite-Gypsum.
	Bordeaux Mixture and Lead Arsenate.
	Zinc-Arsenite-Gypsum
Series IV.	Electro-Bordo-Lead.
	Zinc-Arsenite-Gypsum.
	Bordeaux Mixture and Lead Arsenate.
	Zinc-Arsenite-Gypsum.
	Sulphur-Zinc-Arsenite.
	Zinc-Arsenite-Gypsum.

*Plan II. has been omitted.

"There were four series of plots all approximately of the same size except those of series IV, which were less than half the area of the others. The general contour of the field was rather irregular, but this did not affect the results at all. Throughout the growing period, the vines on the Bordeaux plots were easily superior to the vines on the other plots with the exception of that in the first series where, for some inexplicable reason, there was quite a lot of tip-burn, especially evident about June 30th. Early and late blights were conspicuous by their absence, while only a few hills were affected by Dry Rot *(Fusarium oxysporum)*. Examination of the field on August 16th revealed the plants on the Bordeaux plots still green and quite vigorous, while on the other plots they were quite dead. The potatoes were dug on September 1st, and the following days, and an observer casting his eye over the field could with a little discrimination, pick out the plots treated with Bordeaux mixture by reason of their being less over-grown with weeds. This in itself would point to the invigorating effect of the mixture. The potato vines become so sturdy by reason of its application that they suffer less from competition with inimical weeds, especially crab-grass.

Yield Detailed According to Series.

Table IV—Robbinsville.

Nature of the Application.	TOTAL YIELDS IN BUSHELS PER ACRE.				Avg of the four series.
	Series I.	Series II.	Series III.	Series IV.	
Bordeaux Mixture and Lead Arsenate	233 88	310 75	328 31	290.62	290 89
	249 52	225 24	258.71	228 10	
Gypsum–Zinc–Arsenite	231.74	259.49	245 19	223.94	248 98
	273.13	249 99	314.34	228.44	
Sulphur–Zinc–Arsenite	273 60	266.19	260 16	160 38	240 08
Electro Bordo–Lead	256.93	241.59	312.30	253 12	265.98

Average gain in bushels per acre of Bordeaux plots over check plots	41 41
Average gain in bushels per acre of Bordeaux plots over Sulphur plots	50.31
Average gain in bushels per acre of Bordeaux plots over Electro Bordo Lead	24 41
Average gain in bushels per acre of Bordeaux plots over all others	38 71

Yields Detailed According to Firsts and Seconds.

Table V—Robbinsville.

Nature of Application.	YIELD IN BUSHELS PER ACRE.								Aver. of the four series.	
	Series I.		Series II.		Series III.		Series IV.			
	1sts.	2nds.	1sts.	2nd.	1sts.	2nds.	1sts.	2nds.	1sts.	2nds
Bordeaux–Mixture–Lead–Arsenate	223 06	8.86	297 85	12 90	317 99	10.32	265 62	25 00	276 13	14 27
	241.66	7.86	217.58	7 66	248 23	10.48	202 07	26.03		
Gypsum–Zinc–Arsenite	222 02	9 72	252.85	6 61	240 01	5 15	202 07	21 87	236.64	12 34
	259.25	13.88	240.62	9.37	296.20	18.14	217.11	11.33	..	
Sulphur–Zinc–Arsenite	263 88	9 72	256 94	9.25	245.71	14.45	142.69	17.69	224 31	12 77
Electro-Bordo-Lead	247 68	9 25	234 79	6 80	297 34	14 96	228.12	25.00	251.98	14 00

"It will be observed by a glance at the last column that there is very little difference in the average number of bushels per acre of seconds, the divergence in yields being practically confined to the first.

"An examination of the yield on the Bordeaux plot of the first series causes surprise by its very low figure, indeed no other plot in this block did so poorly except one of the check plots where the yield was practically the same. Had it not been for the adverse conditions obtaining on this plot the average yield in the Bordeaux plots as a whole would have been at least 20 bushels per acre more. Similarly the adverse conditions which prevailed on the Sulphur plot of series IV helped to reduce the average yield of tubers per acre on all the Sulphur plots very materially. On the whole, however, experiments carried out on a large field such as this are of more practical value tan if only a few rows were treated. The variations in yield due to varying conditions of soil and fertility would sometimes seem to confute all accepted theories. But in order to demonstrate fully the capabilities of any spraying material as well as those of the field on which the treated crop is grown, one must be fully acquainted with the several conditions which might influence the results either beneficially or adversely.

"As regards previous cultivation, the field at Robbinsville had borne a potato crop for three years (1912-13-14). In the fall of 1912 it had been sown in rye, which was ploughed in the following spring. After the potato crop had been dug this same operation was repeated in the fall of 1913 and the spring of 1914. Fertilizer of the formula 4-8-10 was applied with the seed at the rate of 1,500 pounds per acre.

Cost of Spraying and Dusting.

"The expense attached to the operation of applying insecticides varies with the kind of material and the type of machine employed in spraying or dusting as the case may be. Even if we consider Bordeaux mixture alone it would not be possible to state a cost which would hold good for all localities and for the various stages in the growth of the same crop within the same locality, because the luxuriance of the vines must be taken into account with regard to the amount of material necessary to cover them satisfactorily. Jones*, formerly of Vermont, states the average cost of spraying one acre of potatoes three times using 200-500 gallons at one cent per gallon as $7.00.

"The following table will give one an idea of this year's expenses at Freehold, Robbinsville and Elmer:

*L. R. Jones, Sixth Annual Rept. Vermont Agr. Exper. Sta., 1892.

Table of Comparative Costs of Materials.

Table VI.

MATERIAL.	No. of lbs. per application.	Time in hours	Cost of labor of man and team per hour.	Cost of material per lb.	Cost of each application.	No. of applications.	Cost per acre for total number of applications.	Cost per acre for each application.
1. Freehold. Bordeaux and Lead Arsen. (5-5-50) .								
Bluestone.	20.			05				
Lime.	20	5	.30	01	5.10	4	4.40	1.10
Lead Arsen.	12.			.20				
Lead Arsen.	*50*	*6*	*.30*	*.20*	*11 80*	*4*	*3 85*	*.96¼*
Ansbacher's Bordeaux-Lead.	41.	3	.30	10	5 00	4	5 12	1 28
Sul.-Gyp.-Lead-Arsen. (2-3-1)	144	3	.30	06¾	10.50	4	10 70	2.67½
2. Robbinsville. Bordeaux-Lead-Arsen. (5-5-50). .								
Bluestone.	30.			.05				
Lime.	30	7	.22	.01	6 94	3	5.11	1 70½
Lead Arsen.	18			.20				
Gyps.-Zinc-Arsenite (5-1).	432	6	22	.06¼	28 32	3	6.99	2 33
Electro Bordo-Lead.	72.	3	22	.10½	8.22	3	5 94	1.98
Sulphur-Zinc-Arsenite	*144.*	*2½*	*.22*	*.05½*	*8 47*	*3*	*6 03*	*2 01*
3. Elmer. Bor.-Lead-Arsenate (5-5-50).								
Bluestone.	13.5			.05				
Lime.	*13.5*	*1.5*	*.30*	*.01*	*2.76*	*4*	*6.20*	*1.55*
Lead Arsen.	7.5			.20				
Lead Arsen.	30.	1.5	.30	.20	6.45	4	5.04	1.26
Kil-Tone	27.	1	.30	.13	3.81	4	8.56	2.14
Sulphur-Lead-Arsenate	61.	1	.30	.058	3.838	4	8 64	2.16

1. At Robbinsville only three applications were made except on the Sulphur-Zinc-Arsenite *plots where those of Series I and II received four treatments, as also 16 rows of the corresponding* plot in Series III.

The figures in the last column speak for themselves and at once show one how the cost of similar treatments may vary in different places in the same State.

Control of the Potato Flea-Beetle.

"In New Jersey as well as most of the potato growing states, this diminutive pest has long been recognized as a serious pest, detrimental not only because of the damage committed directly by its fenestrating the leaves but also indirectly in that the tiny injuries serve as a means of incursion for early blight. When one considers that in cases of severe attack anything from 10 per cent. to 20 per cent. of the leaf surface on a single hill might be destroyed one can form a somewhat rough idea of the adverse effect on the yield which this reduction in the assimilating power of the leaves causes.

"Probahly on account of its insignificant size, very little attention has been paid to the life-history or means of control of the flea-beetle, and one author seems to accept without test what another has experienced. Indeed it is only quite recently that the true facts of its larval behavior have been diagnosed and whereas it was generally accepted by Harris,* Riley† and Packard‡ that the larva was a leaf miner like others of its

*Harris, T. W., Insects Injurious to Vegetation, p. 127, 1862.

†Riley, C. V., Missouri Rept. State Ent. I, p. 101, 1869.

‡Packard, A. S., N. S. Geol. and Geog. Survey of Colorado and Adjacent Territory, 1875, p. 732.

congeners, such as *Haltica nemorum*, the flea-beetle of turnips and other Cruciferæ in England, it has been only within recent years that it has been found to feed on the subterranean tubers and roots of the potatoes as well as the roots of the tomato* and allied solanaceous plants. The attack on the tuber gives rise to a condition known as "pimply," formerly assigned to the activities of the scab organism, the real cause being discovered by Stewart.† The same author (loc. cit.) says that in 1895 in Long Island the damage was so noticeable that potatoes suffered a reduction tn price of five cents.

"The omniverous habit of the adult is well known and although the species has a dietetic preference for the *Solanaceæ*, yet it can satisfy its appetite on almost any of the commoner weeds found near the margins of potato fields. The following are some of the food plants cited by various authors, the list being by no means exhaustive: potato, tomato, eggplant and pepper (O. Lugger‡), Jamestown weed, nightshade (F. H. Chittenden§), radish, turnip, cabbage, raspberry, sunflower and various members of the squash family (C. M. Weed‖), beets (A. S. Packard¶).

"An attempt was made during the season to arrive at some idea of the comparative intensity of the flea-beetle injury by making counts of the fenestrations on the leaves of individual shoots. Although a short table has been prepared showing the averages of these results, it is very doubtful if this method of measuring the degree of infestation is very successful unless one can make daily records. This was impossible because the spraying and dusting of the potatoes allowed only a short stay at a time at each place. However, the results, such as they are, have been tabulated in the hope that they might be of some use in stimulating others who have opportunity to attack the matter along this line.

*Chittenden, F. H., Bull. No. 19, N. S., U. S. Dept. Agr., 1899, p. 89.
†Stewart, F. C., Bull. 113, N. S., N. Y. Agri. Exper. Sta., Geneva, 1896, p. 311.
‡Lugger, O., Bull. 66, Minn. Agr. Exper. Sta., 1890, p. 247.
§Chittenden, F. H., Loc. cit., p. 90.
‖Weed, C. M., Bull. 29, N. H. Coll. Agr. Exper. Sta., p. 3, 1893.
¶Packard, A. S., Loc. cit., p. 732.

Table VII.

Nature of Application.	Date	Locality	No. of shoots.	Aver. No. of leaves per shoot.	Aver. No. of fenestrations per leaf
Untreated	*June 10*	*Elmer*	*20*	*15*	154 5
Bordeaux-Lead-Arsenate	" "	"	20	15	92
Kil-Tone	" "	"	20	15	142
Lead Arsenate .	" "	"	20	15	138 6
Sulphur-Lead-Arsenate .	" "	"	20	15	208 4
Bordeaux-Lead-Arsenate. . . .	June 29	Robbinsville	20	14	9 3
Vreeland's Electro Bordo-Lead .	" "	Robbinsville	20	15	9 7
Gypsum-Zinc-Arsenite	" "	Robbinsville	23	14	8 3
Sulphur-Zinc-Arsenite . . .	" "	Robbinsville	15	13	11
Untreated	July 1	Freehold	23	13	7 7
Untreated	" 9	"	21	13	9
Bordeaux-Lead-Arsenate.	" "	"	26	8	4 9
Ansbacher's Bordeaux Lead .	July 10	"	29	9	7 15
Lead Arsenate.	"	"	29	9	6 3
Sulphur-Gypsum Lead-Arsenate	"	23	23	9	7 7
Bordeaux-Lead-Arsenate .	July 13	Robbinsville	33	11	8 9
Vreeland's Electro Bordo-Lead .	" "	Robbinsville	30	8	21.5
Gypsum-Zinc-Arsenite . .	" "	"	22	8	13 54
Sulphur-Zinc-Arsenite . .	" "	"	21	9	13
Bordeaux-Lead-Arsenate .	*July 16*	*Elmer*	27	13	15
Kil-Tone .	" "	"	28	14	28
Lead Arsenate	" "	"	25	15	21
Sulphur-Lead-Arsenate .	" "	"	28	14	28
Untreated (Late crop) . .	Aug 22	"	23	9	32

"As has been said before a great deal of confidence cannot be placed on these figures as it is almost impossible to judge the gross intensity of the seasonal attack of the flea-beetle, because the numbers which are present in some definite locality at any given time, are determined by several conditions amongst which the most important are temperature and humidity. It will thus be readily understood why it is important to make continuous daily counts. If these extend only over a short period, the figures only hold good for that one period and cannot be expected to indicate the intensity except for the time stated.

"In one case, at Robbinsville, the Bordeaux Mixture seemed to be less efficient than the Gypsum-Zinc-Arsenite in warding off the flea-beetle and it almost appears as if dry poisons for the time they remain on the leaves are more effective in their repelling function than wet poisons. In the long run, however, by reason of their greater powers of adherence, the latter give the best results, which accounts for the better showing of the Bordeaux Mixture and the Lead Arsenate. At Freehold, July 9th, the Bordeaux plots had the least injury and similarly again at Robbinsville on July 13th and Elmer July 16th. Unsprayed vines, as is to be expected, are more liable to flea-beetle injury, and at Elmer August 22nd, on the late crop the average number of holes per leaf was during the second worst attack of the season. The intensity of the infestation at Elmer when the plants were yet young can be judged by results obtained on June 10th at the same place. Here the Bordeaux-Lead-Arsenate combination proved its qualities in keeping the pest at bay.

"The fact that the average number of injuries, as judged from the table, were much greater at Elmer on June 10th is due to the fact that the counts

were made on the large radical leaves of the vines, which, on account of their having appeared first, suffer greater cumulative damage than the younger leaves on the top shoots, which alone were considered in the later reckonings.

"The control of any insect pest by such measures as time and experience have so far taught must be reduced, for practical purposes, to a basis of dollars and cents. The total destruction of the flea-beetle, like that of any other insect pest, would mean unlimited expenditure and is practically impossible. As an insect indigenous to the United States, this pest will for ever, as long as potatoes are grown, levy a tax upon the farmer so that the question resolves itself into one of reducing the tax to a minimum by some measure of control. Three principal methods of attack have been employed in abating injurious insect pests, classified as follows: (1) Treatments which kill the insects; (2) measures that will restrict their abundance and act temporarily as repellants; (3) natural checks, such as insect or fungus parasites.

"Hitherto it has been the general plan to tackle the problem of flea-beetle control by means of repellants, and although Arsenate of Lead and Bordeaux Mixture have on many occasions proved efficient, many of the inert powders and dusts recommended are practically of little benefit. Because of its activities and peculiar habits, the problem of killing the insect outright presents many difficulties, for it is essential that, for the rapid administration of a lethal dose, the material employed must actually hit the insect and be retained there until the animal is paralyzed beyond recovery. What I have in mind is pyrethrum mixed with an adhering agent such as gelatin, glue, or soap. After some experiments had been carried out in the laboratory with several different substances hereafter tabulated, it was decided to try several of these on some early and late potatoes with a view to discovering an agent capable of killing the beetles quickly. After several failures an infusion of pyrethrum mixed with Lead Arsenate in which gelatin is incorporated gave most satisfactory results and seemed to fulfill one's best expectations. This combination of insecticides is made up in the proportion of 6 pounds of pyrethrum to 60 gallons of water to which sufficient gelatin or soap is added to ensure that a film of the liquid when sprayed on the leaves will adhere readily. In preparation, the pyrethrum is first made into a paste by the addition of hot boiling water, then diluted with hot water and cooled, and then further diluted to the required strength with cold water, the gelatin solution being previously stirred in. To get the best results this insecticide should be applied at 100 pounds pressure so that it hits the vines as a fine mist.

"The laboratory experiments were carried through in lamp-globes covered with muslin. Inside the globes a small vessel for holding water was placed into which slips cut from the vines and treated with the various

preparations tabulated, were cut. Flea-beetles in varying numbers which were always previously counted were introduced and the effects noted after a period of hours or days as the case might be. The penultimate column of the table, which follows, records the percentage mortality, but this is only of interest in so far as it gives one an indication merely of the value of the insecticides. The conditions were too unnatural to allow of the experiments being a real test.

Table VIII—Experiments in Control of Flea-Beetle.

MATERIAL.	STRENGTH OF MATERIAL.	Number of specimens	Duration of test	Alive.	Dead.	*Percentage* mortality.	Remarks
1. Zinc Arsenite		20	2 days	2	18	90	All dead after three days
2. Zinc Arsenite, paste	4 lbs. to 50 gal	48	2 "	4	44	91.6	Plants killed
3. *Zinc Arsenite, paste*	4 lbs to 50 gal	50	2 "	40	10	20	All dead after nine days
4. Paris Green, powder		40	3 "	5	35	*87.5*	*All dead after seven days*
5. Paris Green, powder		65	3 "	15	50	76.9	All dead in ten days
6. Tobacco dust		36	1 day	3	33	91.6	The effect seems to vary, acting quickly on some and less so on others
7. Hellibore, powder		60	2 days	6	54	90	Acts quickly but loses effect rapidly
8. Bordeaux-Lead-Arsenate-Black-Leaf-40	5-5-50—3½ lbs—1 pint	51	2 "	24	27	52.9	All dead in six days
9. *Zinc-Arsenite-Black-Leaf-*40	3½ lbs. 5 pints to 50 gals	86	6 "	20	46	69.6	Leaves become chlorotic *and die*
10. Lead-Arsenate-Black-Leaf-40	3½ lbs. 5 pints to 50 gals.	*66*	*6* "	14	52	78.7	Leaves burnt by arsenic
11. Lead Chromate, powder		45	10 "	36	9	20	No injury to leaves but not efficient as insecticide.
12. *Lead-Chromate-Black-*Leaf-40	3½ lbs 5 pints to 50 gals.	68	4 "	50	18	25.4	No *injury to leaves.*
13. Lead-Arsenate-Molasses	3 lbs. 3 lbs. in 50 gals.	52	7 "	16	36	69.2	No injury to leaves at first but finally turned yellow and died.
14. Lead-Arsenate-Molasses	3 lbs. 3 lbs in 50 gals	66	5 "	39	27	40.9	No injury at first; chlorosis *followed.*
15. Lead-Arsenate-Molasses	3 lbs. 3 lbs. in 50 gals.	48	5 "	19	29	64.1	No injury at first; chlorosis followed.
16. Black-Leaf-40-Soap	1 pint—4½ lbs. to 100 gals	75	2 "	30	45	60	*Leaves eaten quite a lot*
17. Black-Leaf-40-Soap	2 pints—4½ lbs. 100 gals.	60	2 "	26	34	56.6	Leaves eaten quite a lot.
18. Barium-Chloride-Molasses	2% *sol. with 5 lbs. Molasses* to 100 gals	72	3 "	26	46	63.8	Kills vines quickly; *valueless*
19. Barium-Chloride-Molasses	2% sol. with 5 lbs Molasses to 100 gals.	72	3 "	26	46	63.8	Kills vines quickly; valueless
20. Pyrethrum		60	6 hour		60	100	Very effective but rapidly becomes weak in its action.
21. *Pyrethrum-Sulphur*	Equal parts	50	6 "	5	45	90	Those still alive feeble in their movements; did not recover.
22. Pyrethrum *Infusion*	*6 lbs to 60 gals*	50	10 "	2	48	96	*If covered* only two hours the specimens recover
23. Sulphur		46	1 day	46	0	0	No feeding done.
24. Bor.-Deth, powder		54	2 days	24	30	55.5	Non-injurious to the vines.
25. Pyrox	8 lbs to 50 gals.	46	4 "	14	22	47.8	Non-injurious to the vines

A Parasite of the Flea-Beetle.

"Throughout the summer from the middle of July until the beginning of September when a period of rather low temperature was experienced, sending the flea-beetle into hibernating quarters, a small species of braconid (*Perilitus epitricis* Viereck)* was often observed in close association with it on the potato vines. The following observations were made on July 30th. As the flea-beetle moved over the leaf surface the hymenopteron follows closely in the rear with its two antennæ outstretched, one on each side of the beetle. Whenever the latter stops, the braconid follows suit and remains often quite motionless. Sometimes, however, it becomes quite excited and rapidly encircles its host. When about to attack the hymenopteron orients itself either anteriorly or posteriorly in a direct line with the flea-beetle and artfully recurving its abdomen downwards and forwards, strikes it in the weak part of its armour, the intersegmental portion of the abdomen. Thus the act of oviposition is completed and in many cases it was repeated three or four times in the same host by the same parasite. From several specimens of flea-beetles captured during the summer the same insect was reared, thus verifying my field observations. The point of emergence usually is a hole found at the posterior end of the parasitized beetle in the anal region in the shape of a tiny aperture.

"In Bulletin 19, N. S., Chittenden† dealing with the flea-beetle, attacking solanaceous plants, says that adult beetles *(E. cucumeris)* collected near Washington were parasitized evidently by the same species which is mentioned (loc. cit. p. 85) as preying upon *E. parvula*, the tobacco flea-beetle."

Fly Control.

This work is a continuation of that undertaken last year. At the end of the season of 1913 the writer felt, that in view of the fact that after all known breeding places had been eliminated in so far as was practicable on the college general and dairy farms a considerable number of flies were still present in the pig house, horse barn and cow barn, investigations of a more fundamental type were needed. Accordingly, attention was turned sharply to the species concerned and to their breeding and other habits. Further studies were made of baits, manure disposal, and prevention of breeding in stalls.

It was not financially practicable for the New Brunswick Board of Health to carry on a fly campaign and attention was concentrated on the college general and dairy farms.

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*This was identified by Mr. J. C. Crawford, of the Bureau of Entomology, U. S. Dept. of Agric., and is a new record for New Jersy.

†Chittenden, F. H., Bull. 19, N. S., U. S. Dept. Agric., 1899, p. 89.

Fly Control on the College Farm.

BY
C. H. RICHARDSON, Assistant Entomologist.

Introduction.

"The Board of Health of the City of New Brunswick being unable financially to undertake a fly campaign it was thought best to concentrate the work in some rather isolated locality where fly breeding could be practically eliminated. The College Farm, where a part of the work of last year was conducted, was again chosen as the best available place for these investigations. The work was started on April 24th and terminated about November 1st.

"These studies were made under the supervision of Dr. T. J. Headlee, to whom the writer wishes to express his appreciation for many helpful suggestions. He is also indebted to Mr. J. V. Bissett, formerly Assistant in Chemistry, Rutgers College, for aid during July and August, to Dr. C. H. T. Townsend and Dr. Frederick Knab, of the Bureau of Entomology, and to Mr. R. R. Parker and Mr. C. W. Johnson for the identification of specimens.

"The investigations of the Department of Entomology of this station during the summer of 1913 showed that complete fly control could not be effected by the use of fly traps as ordinarily constructed, that at most they could be only an adjunct. The elimination of breeding places was held to be highly important and it was found that iron sulphate and carbon bisulphide were useful larvicides and that sulphur was an effective fumigant of adult flies. The great importance of co-operation in anti-fly work was brought out as well as the effectiveness of partially complete fly-breeding control.

"The work undertaken this year was largely a continuation of last year's investigations, but more emphasis was given to the study of the fly fauna of the farm, especially to those species which frequent milk, and thus are possible carriers of infectious human diseases. A careful survey of the entire farm was made and all breeding places were regularly cleaned and inspected. The work on larvicides was directed rather to discover new materials and to formulate new methods than to test the older ones. Minor studies were made on fly-trap baits, on the distance flies can travel, and on compost.

Studies on the Fly Fauna of the College Farm.

"This work was undertaken to furnish data on the number of species of flies which inhabit a typical New Jersey farm, especially those species which, because of their omnivorous feeding habits or their blood-sucking propensities are a source of danger or annoyance to the farmer and his live stock. Particular attention was given to the flies which were captured regularly in milk-baited traps, and because of their dung feeding

habits, might, through the medium of milk, convey germs of various diseases to man. Flies were also bred from the various manures on the farm.

Species Which Are Attracted to Milk.

"Fly traps 12 inches in diameter and 30 inches high were employed in this work. They were placed in the following locations: in the pig barn above the feed troughs; at the poultry plant brooder house near an open window and in the ed house; at the compost heap near the greenhouses; in the horse barn and at the horse barn manure pit; in the cow barn, the calf barn and at the cow barn manure pit. The pig barn, the houses of the poultry plant, the greenhouses and the horse barn form a group of buildings which lie close to the residential section of the City of New Brunswick. The cow barn and calf barn form another group given up entirely to dairying about one mile distant from the horse barn.

"About fourteen traps were maintained from May 6th until October 5th, after which the number of flies was so reduced that the trapping was not profitable. The traps at the feed house, compost heap, horse barn and cow barn manure pit were removed at various times because of the small size of the catch, and were taken to the other places to increase the number of traps there.

"Fresh milk and bread or bran were used for bait, which was usually renewed every other day, although this program was not always strictly adhered to. The traps were emptied once a week and estimates were taken of the different species caught. The following is a list of the flies which were caught often enough to indicate that their capture was not accidental:

Abundant species: *Calliphora erythrocephala* Meig., *Lucilia sericata* Meig., *Phormia regina* Meig., *Musca domestica* L., *Muscina stabulans* Fall., *Fannia canicularis* L.

Species less abundant: *Ravinia communis* Parker, *Ravinia latisetosa* Parker, *Sarcophaga bullata* Mans., *Sarcophaga hæmorroidalis*, Meig., *Sarcophaga helicis* Town., *Pollenia rudis*, Fab., *Cynomyia cadaverina* Desv., *Lucilia cæsar* L., *Morellia micans* Macq., *Graphomyia americana* R. D., *Muscina assimilis* Fall., *Ophyra leucostoma* Wied., *Fannia scalaris* Fab., *Scatophaga stercoraria* L.

"The first list includes species which were captured regularly and in abundance throughout the season, the second list, species of which less than fifty were captured during the season. Several species of anthomyids cannot now be included, because of a question as to their identity.

"Four species in the list of those designated as abundant, namely, *Calliphora erythrocephala* Meig., *Musca domestica* L., *Muscina stabulans* Fall. and *Fannia canicularis* L., have been bred from or found upon human excreta by Howard* and the same author has likewise incriminated *Cynoymia cadaverina* Desv., *Lucilia cæsar* L., *Morellia micans* Macq., *Ophyra leucostoma* Wied., and *Scatophaga stercoraria* L. Thus nearly one-half of the flies which visited milk on the College Farm are known to visit human excrement.

*A contribution to the study of the insect fauna of human excrement. Proc. Wash. Acad. Sci. 1900. Vol. 2. pp. 541-604.

Breeding Places.

"An effort was made to locate the breeding places of the different species of flies found on the farm. Horse manure, cleanings from beneath horse stalls, cow manure, pig manure, chicken manure, compost and rotting ensilage were examined for fly larvæ and pupæ from time to time. When evidences of breeding were found, samples of the manure or compost were placed in breeding cages and the adult flies were reared. A number of flies remain unidentified and are omitted from the following lists:

Horse manure: From manure pit—*Musca domestica* L., *Stomoxys calcitrans* L., *Fannia canicularis* L.; cleanings from underneath stall boards—*Musca domestica* L., *Muscina stabulans* Fall., *Fannia canicularis* L., *Fannia scalaris* Fab.

Cow manure. *Eristalis tenax* L., *Ravinia communis* Parker, *Ravinia latisetosa* Parker, *Pseudopyrellia cornicina* Fab., *Morellia micans* Macq., *Musca domestica* L., *Lyperosia (Hæmatobia) irritans* L., *Muscina stabulans* Fall., *Myospila meditabunda* Fab., *Scatophaga stercoraria* L., *Lonchæa deutschi* Zett., *Sepsis* sp.

Pig manure: *Culicoides specularis* Coq., *Ravinia communis* Parker, *Ravinia latisetosa* Parker, *Musca domestica* L., *Myospila meditabunda* Fab., *Scatophaga stercoraria* L., *Borborus* sp., *Sepsis* sp.

Chicken manure: *Musca domestica* L.

"From the standpoint of the number of species bred, cow manure was the most important producer of flies, chicken manure the least. But under ordinary conditions, horse manure breeds the largest number of house flies (*Musca domestica* L.), which exceed all others in abundance and, therefore, it must be considered the substance most desirable for elimination. House flies were bred not only from horse manure, but from cow manure, pig manure and chicken manure. They did not in any instance issue from cow droppings in the pasture and only bred in this substance when it was mixed with straw. All the other species reared from cow manure came from droppings gathered from the cow pasture. Chicken manure offered a breeding place for house flies only when moist. It is, however, a substance which must be considered in any sanitary operations.

"About one-half of the species which were regularly attracted to milk were bred from various kinds of animal manure on the College Farm and are therefore liable to be a source of contamination for any milk improperly protected.

ANNOTATED LIST OF THE FLIES SEEN UPON THE COLLEGE FARM.

"This list makes no claim to completeness since it contains largely those species which frequented the dwellings or bred in the various manures of farm animals. A number of tabanids were observed at the cow barns during mid-summer but they are not included here. A few species, chiefly anthomyids, are still unidentified and are not mentioned in this list.

Chironomidæ.

Culicoides specularis, Coq.
Two specimens of this minute mosquito-like gnat emerged July 11th from a pig dung which was placed in a breeding cage June 30th.

Culicoides variipennis, Coq.
This biting gnat was abundant on the windows at the cow barn, May 10th. Many females were gorged with blood which they had taken from the cows.

Bibionidæ.

Scatopse, sp.
An unidentified representative of this genus was captured in a net on May 10th

Simulidæ.

Simulium hirtipes, Fries.
This "black fly" was captured on the farm, May 10th, but not seen later

Stratiomyidæ.

Ptecticus trivitatus, Say.
A single specimen was captured in a milk-baited trap at the cow barn manure pit, July 10th.

Syrphidæ.

Eristalis tenax, L.
This drone fly bred in the cow barn manure pit during May and June. It was never taken in the traps.

Sarcophagidæ.

Bottcheria latisterna, Parker (?)
A single specimen resembling this species was captured at the horse barn manure pit September 28th.

Ravinia communis, *Parker.*
Thirteen individuals were captured at the big barn and the horse and cow barn manure pits from May 19th till September 28th. Also reared from cow dung isolated June 5th, during July and on August 27th, and from pig dung isolated August 26th.

Ravinia latisetosa, Parker.
Four specimens were captured on the farm and at the horse barn and cow barn manure pits from May 19th till August 7th. The species was bred from cow and pig dung isolated in cages on August 26th and 27th, respectively.

Sarcophaga assidua, Walk.
One specimen from a trap in the horse barn July 10th.

Sarcophaga bullata, Mans.
Three specimens from the farm dated May 19th. One taken from a trap at the cow barn manure pit, *July 18th.*

Sarcophaga falculata, Pand.
One specimen from a trap in the brooder house, July 27th.

Sarcophaga dalmatina, Schiner.
One specimen from the brooder house, August 21st.

Sarcophaga hæmorrhoidalis, Meig.
Four specimens from the horse barn manure pit, August 1st, 7th, 21st, and September 28th, and one from the brooder house, August 7th.

Sarcophaga helicis, Towns.
First captured on the farm on May 19th, and subsequently during July and August at the horse barn manure pit and the cow barn. Seven specimens obtained.

Sarcophaga scoparia, Pand.
One specimen, cow barn manure pit, July 18th.

Sarcophaga sarraceniæ, Riley.
Taken once at the cow barn manure pit, August 1st, and once at the pig barn, August 21st.

Sarcophaga utilis, Aldrich.
One specimen from the farm May 25th, and another from the horse barn manure pit, October 5th.

Muscidæ.

Pollenia rudis, Fab.
The cluster fly was caught in milk-baited traps at two places: the horse barn manure pit and the cow barn manure pit. The first individual was taken June 3rd, the last, August 7th. Ten specimens were captured in all; the largest number taken from a single trap was five.

Cynomyia cadaverina, Desv.
This blow-fly-like species was not detected at the College Farm till May 13th, although *specimens were collected in New Brunswick on April 24th, 28th, 29th and May 1st and 12th.* It seemed to reach its maximum abundance late in May. Eleven specimens were taken from

traps on May 19th and 25th. One was taken on June 3rd and the species was not seen again till September 28th when two specimens were captured in a trap at the horse barn manure pit.

The records from the College Farm agree in general with those from the entire State* which show that Cynomyia cadaverina is present during May, and again during September and October. What becomes of this species during July and August?

Calliphora erythrocephala, Meig.

This common blow-fly was captured in the milk-baited traps throughout the period covered by these investigations. Seldom more than four or five were taken from a single trap. The first individuals were captured on April 24th, the last seen on October 20th. Although never present in large numbers in a single catch, it is, on account of its dung feeding habits and its continual presence throughout the season, a species to be feared.

Calliphora vomitoria, L.

This blow-fly was captured but twice, on May 19th and 25th, although it was expected to be abundant. It is said to occur everywhere in New Jersey at all seasons† but was far surpassed in numbers on the College Farm by Calliphora erythrocephala, Meig.

Lucilia cæsar, L.

This green bottle fly is closely allied to the next species, and is supposed to be more abundant in New Jersey. Only seven out of about fifty specimens of Lucilia which were saved, showed distinctly the characters of Lucilia cæsar, L. They were collected from traps during July and August.

Lucilia sericata, Meig.

This fly was observed on the farm in considerable abundance from May 19th till October 5th. During June about 200 specimens were taken from one trap at the cow barn manure pit. After that time it was not so plentiful and a trap seldom contained more than fifteen or twenty. This is an important species early in the summer before house flies are present in large numbers.

Phormia regina, Meig.

During June this species appeared in considerable numbers. About 250 were removed from a trap at the cow barn on June 3rd and on June 30th in a single trap at the cow barn manure pit, which had not been emptied since June 3rd, contained approximately 200 of these flies. After that time a single trap seldom contained more than four or five. It was first captured on May 25th, and was present at least till September 5th. The records indicate that this is an important species early in the summer and that it is present till well into the fall.

Pseudopyrellia cornicina, Fab.

Bred from cow dung isolated in breeding cages August 5th and 27th; about twelve individuals issued. It was not captured in milk-baited traps.

Morellia micans, Macq.

First captured on June 3rd in a trap at the cow barn manure pit from which four specimens were taken. Another was captured at the horse barn manure pit on September 28th.

Eleven specimens were reared from cow manure taken from the cow pasture on the following dates: July 22nd; August 25th; August 27th. Many larvæ were found in cow manure in the pasture on August 5th.

Musca domestica, L.

The house fly or typhoid fly was by far the most abundant species on the farm. The following table was compiled from trapped specimens and from observations made at intervals throughout the season. While making no claims to absolute accuracy, it is believed, the table gives, in a general way, a true picture of the relative abundance of house flies and other flies on the College Farm in 1914.

*Smith "Insects of New Jersey", Ann. Rept. N. J. State Mus. 1909, p. 786.
†Smith, loc. cit., p. 786.

Table Showing Comparative Abundance of House Flies at College Farm in 1914.

H. F.—House Flies. O. F.—Other Flies

DATE 1914.	Pig Barn.		Poultry Plant Brooder House.		Horse Barn.		Horse Barn Manure Pit.		Cow Barn.		Cow Barn Manure Pit.		Calf Barn.	
	% H. F.	% O. F.	% H. F.	% O. F.	% H. F.	% O. F.	% H. F.	% O. F.	% H. F.	% O. F.	% H. F.	% O. F.	% H. F.	% O. F.
4/24	....	100	....	100	....	100	....	100	....	100	....	100	....	100
5/6	....	100	....	100	....	100	....	100	....	....	....	....	....	....
5/9	....	....	....	....	....	....	....	....	....	100	....	100	....	100
5/13	....	100	....	100	....	100	....	100	.05	99.95	....	100	....	100
5/19	12.5	87.5	7	93	....	....	....	100	5	95	....	100	....	....
5/25	22	78	....	100	1	99	11	89	....	....	....	....	....	....
6/2	7	93	7	93	5	95	....	....	....	....	....	....	....	....
6/3	....	....	....	....	....	....	....	....	16	84	4	96	30	70
6/9	20	80	10	90	10	90	....	....	20	80	....	....	30	70
6/20	....	....	....	....	....	....	....	....	85	15	....	....	90	10
6/30	....	....	....	....	....	....	....	....	85	15	1	99	....	....
7/2	95	5	....	....	70	30	....	....	....	....	....	....	....	....
7/10	90	10	98	2	....	....	1	99	99	1	....	100	....	....
7/18	98	2	98	2	....	....	....	....	....	....	5	95	99	1
7/24	....	....	....	....	....	....	....	....	60	40	....	....	....	....
7/27	99	1	96	4	....	....	60	40	60	40	....	....	99.9	1
7/29	80	20	....	....	....	....	50	50	....	....	....	....	....	....
8/1	99	1	85	15	....	....	66	34	....	....	....	....	99.0	1
8/4	99	1	....	....	....	....	....	....	....	....	....	....	....	....
8/7	99	1	90	1	....	....	95	5	....	....	....	100	....	....
8/10	....	....	....	....	....	....	....	....	3	97	....	....	....	....
8/21	99	1	96	4	....	....	95	5	....	....	....	....	....	....
8/25	....	....	....	....	....	....	....	....	10	90	....	....	99	1
9/1	99	1	....	....	....	....	95	5	....	....	....	....	....	....
9/14	99	1	....	....	90	10	....	....	....	....	....	....	....	....
9/16	....	....	....	....	....	....	....	....	15	85	....	....	95	5
9/23	99	1	70	30	....	....	....	....	....	....	....	....	....	....
9/28	....	....	....	....	....	....	70	30	25	75	....	....	90	10
9/29	99	1	67	33	....	....	....	....	....	....	....	....	....	....
10/5	90	10	53	47	....	....	75	25	....	....	....	....	....	....
10/20	80	20	....	....	40	60	....	....	30	70	....	....	90	10

"House flies were seen at the cow barn on May 13th and by May 19th they had appeared in small numbers at the pig barn. They gradually increased during May and June, and by July 1st were more abundant than any other species. By the middle of September they had begun to decrease perceptibly. On October 5th, six traps stationed at the pig barn, brooder house and horse barn manure pit caught only 210 flies, and on October 20th, the reduction was still greater.

"The pig barn and calf barn sustained the highest percentage of house flies thoughout the season. This was due to a large and constant supply of food in the form of milk, bran, tankage and other materials which remained in the troughs and pails after the animals were fed or was spilled on the floor. The cow barn also attracted a large number of house flies, but late in July, Stomoxys calcitrans, L., appeared in force and the relative percentage of house flies dropped considerably. The horse barn and cow barn manure pits did not prove as attractive, since the manure was regularly removed from them, and consequently fewer house flies were captured there. This was also true to a lesser extent of the brooder house and horse barn. It thus appears that wherever house flies found an abundance of food, they were present almost to the exclusion of all other species, but where their food was present in small quantity, they were largely displaced by other species. Whether this repellant effect was due to their numerical preponderance or to their pugnacity was not determined. However, house flies were observed in pursuit of little house flies (Fannia canicularis, L.) about traps on several occasions.

"Breeding was first discovered in horse manure at a small stable near the cow barn on June 2nd. On June 25th, a few larvæ were found beneath the stall boards in the horse barn. Breeding was detected in moist chicken dung at the poultry plant on July 3rd, and on July 7th myriads of larvæ infested the cleanings from brooder pens (a mixture of chicken dung and sand) which had been used to fill depressions in a road and which a rain had dampened. A few house flies were bred from pig manure taken from the pig yards on August 26th, and in large numbers from the same material gathered September 23rd. Larvæ and pupæ were reported October 15th in a mixture of cow manure and straw beneath a crate from which calves were fed. Larvæ could nearly always be found in the horse barn manure pit, but except in a very few instances, the manure was removed before they had reached large size.

Graphomyia americana, R. D. (maculata, Scopoli).

Six specimens of this strikingly-marked fly were captured in traps at the cow barn manure pit from June 3rd till July 18th.

Stomoxys calcitrans, L.

The stable fly was not seen till May 9th when five or six were found on cows and one on a hog. It did not appear in large numbers till about the middle of July, and from that time it increased so that by July 27th it was as abundant at the cow barn as the house fly. On August 10th three counts were made in the cow barn and 97% of the flies present were stable flies. By September 28th, however, this percentage had dropped to about 75, and on October 20th, when the last observation was made the numbers were very greatly reduced.

A few stable flies were bred from horse manure from the horse barn manure pit on September 14th. Breeding places could not be found near the cow barn, but, as they may breed in accumulations of straw and grass, it would have been easy to overlook them.

Lyperosia (Hæmatobia) irritans, Linn.

The horn fly was first seen on cows at the cow barn on May 10th. On May 19th, it was estimated that 150 horn flies were present on forty cows, but they were not evenly distributed, some cows having ten or twelve on their shoulders, others two or three and still others none at all. Only two of the twenty cows on the east side of the barn were fly infested at 4:00 p. m., the horn flies preferring the cows in the strongest light. By June 6th there had been a great increase in the number of horn flies and the irregular distribution was not so apparent. This increase continued until the middle of July when the maximum was reached. A marked decrease was observed on September 16th and again on September 28th when many of the cows were entirely free from flies. A few horn flies were still present on October 20th.

Horn flies were bred from cow dung which came from the cow pasture on June 30th, but I am confident they were breeding before this date. They were reared again from cow dung isolated in breeding cages on August 27th. Pupæ were collected in considerable numbers on several other occasions during August.

Muscina stabulans, Fall.

The trap records showed that this species reached its height of abundance during June. On June 2nd, fifty specimens were taken from a trap in the brooder house; on June 3rd, 350 were captured in traps in the cow barn and at the manure pit nearby; 235 were taken from the same traps on June 30th. Muscina stabulans, Fall. was also a common species throughout July and August, but diminished in numbers during September. Three specimens were taken on October 5th in the brooder house and at the horse barn manure pit, the latest date they were captured.

Muscina stabulans was only bred twice during the season. A single fly emerged from manure which had been taken from underneath a horse stall on July 15th, and two specimens issued from cow dung isolated in breeding jars on June 5th.

Muscina assimilis, Fall.

Apparently occuring throughout the summer, but not abundant. Seven specimens were trapped on the following dates: June 3rd, July 10th and September 28th. Five of these were captured on September 28th.

Myospila meditabunda, Fab.

A single specimen issued from cow dung which was placed in a breeding cage on August 27th; another was bred from pig dung isolated in breeding cages September 23rd.

Anthomyidæ.

Ophyra leucostoma, Wied.

This little metallic black fly was observed and trapped on the College Farm from June 3rd until September 28th. Nearly one-half of the trapped specimens were captured in the brooder house, and the fact that individuals were observed about chicken dung on two occasions, suggests that they might breed in this substance. Examinations, however, failed to produce any *Ophyra* larvæ.

Ten is the largest number of specimens of this species caught in a single day.

Fannia canicularis, L.

From May 6th till the middle of June, the little house fly was one of the most abundant species on the farm. The traps contained 71% of flies of this species on May 19th. By June 2nd, about 50% of the flies at the pig barn and brooder house were of this species and the next day about 40% of those counted at the cow barn were little house flies. It rapidly decreased after this date, especially in the pig barn and cow barn, but it was observed and trapped there throughout July, August and September in small numbers. In the horse barn, it was still present in considerable numbers on October 5th, and on October 20th was the most abundant fly in the horse barn, but still outnumbered by the house fly at the pig barn.

A number of larvæ, some of which undoubtedly belonged to this species, were found beneath the stall boards in the horse barn on June 25th. It was bred from horse manure taken from beneath the horse stalls on July 15th, and from horse dung taken from the horse barn manure pit September 9th.

Fannia scalaris Fab.

This species, closely allied to the little house fly, was not as abundant as the preceding. It was seen from May 6th till August 7th and reached its greatest abundance on June 25th at the horse barn. Twenty-six specimens were caught in traps or by means of nets.

A single adult of this form was reared from cleanings gathered from beneath a horse stall on July 15th. It emerged on July 31st.

Scatophagidæ.

Scatophaga stercoraria, L.

During the first two weeks in May this yellow dung fly laid its eggs in cow and pig dung in the pastures and in compost near the greenhouses. It was exceedingly abundant at this time. Three specimens were taken in traps during July, and four during the early part of August. The species was last seen in the cow pasture August 25th.

Borboridæ.

Borborus sp.

Two distinct species are included under this head—one captured on the farm on April 24th and another reared from pig dung isolated June 30th.

Sphærocera subsultans, Fab.

There was one specimen taken at the horse barn manure pit, April 23rd, but this species or one nearly like it was seen at the above locality throughout the summer. It was found within manure heaps.

Sapromyzidæ.

Lonchæa deutschi, Zett.

This small black fly was bred from cow dung taken from the cow pasture on July 22nd and August 25th. It was never caught in traps.

Ortadidæ.

Tetanops luridipennis, Lw.

A single specimen was taken from a trap at the horse barn manure pit on July 10th.

Sepsidæ.

Sepsis sp.

This small fly was bred from cow dung taken from the cow pasture on July 5th, July 22nd August 5th and September 24th, and from pig dung from the pig yards on June 30th, July 3rd and September 23rd. It was captured in the poultry plant dung house and at the windows in the cow barn, but never in the traps. Neither have I ever seen it about traps, although it may have entered them at times and escaped again through the meshes of the wire.

Experiments With Baits for Fly Traps.

"Milk and bran or milk and bread were used as baits for the fly traps throughout the summer. Sweet milk was used whenever obtainable. Experimental work done by Morril* showed that fresh beer was a better liquid than milk for fly bait. Three experiments were conducted, each for

*Journ. Econ. Ent., Vol. 6, No. 3, 1914, pp. 268-273.

a number of days, to prove which was the better of these two substances. Two traps (12x30 inches), one baited with milk and bread, the other with beer and bread were placed about ten feet apart in the pig barn. The baits were placed in tin pie plates and were renewed every other day. Results were taken by comparing the number of dead flies in the bottom of each trap at the end of the time, as follows: (1) July 6-8, beer two times as many flies as milk; (2) July 10-15, milk two times as many flies as beer; (3) July 13-15, milk two times as many flies as beer.

In experiment 2 the two traps were almost even on July 14, but by the next day the milk baited trap had again taken the lead. Beer is unquestionably attractive to flies, but these experiments indicate that milk is even a better bait.

Studies on Larvicides.

"The work on larvicides consisted largely in an attempt to find new chemicals suitable to control house fly larvæ in manure. Iron sulphate, borax and pyroligneous acid, which have recently been investigated by Cook, Hutchinson and Scales* were also given some attention.

LABORATORY EXPERIMENTS.

"Seven new compounds besides iron sulphate and borax which have been previously investigated were used in the laboratory tests, the results of which are given in the table below. The larvæ were placed in 60 mm. glass dishes with one ounce of fresh horse manure. The tops were covered with pieces of cotton cloth held by means of rubber bands. Unless otherwise stated, 5cc. of each larvicide solution was applied to each ounce of manure, an amount which gave it a thorough wetting. The dilutions were generally such as would be near a practical one financially should they show larvicide properties. An attempt was made to place ten larvæ in each dish, but was not successful because of the number of eggs and minute larvæ scattered throughout the manure. This will account for the differences in the number of adults which emerged in the experiments.

"None of these compounds except borax, iron sulphate and mercuric chloride was effective at the strengths tested. Mercuric chloride used at the dilution of one part to fifty parts of water is a violent poison and its cost would render the applications too expensive. None of the three successful compounds was of sufficient strength to kill all of the larvæ and some always reached the pupal stage. It is also significant that one seemingly perfect adult fly emerged from a borax and iron sulphate dish. Even under experimental conditions the control with these larvicides is not perfect.

*Experiments in the destruction of fly larvæ in horse manure—U. S. Dept. Agr., Bul. 118, 26 pp., 1914.

Experiment I—Set 8/24—Examined 9/11, 1914.

CHEMICAL.	Dilution grams to cc. of H_2O	Amount Larvicide used.	Amount manure.	Number dead larvæ.	Number dead pupæ.	Number adults emerged.
Control water.	......	5 cc.	1 oz.	None.	None.	17
" "	......	"	"	"	"	23
" "	......	"	"	"	"	11
" "	......	"	"	"	"	27
Sodium sulpho-carbonate.	1:200	"	"	"	"	20
" " "	1:200	"	"	"	"	24
Mercuric Chloride.	1:1500	"	"	"	"	24
" "	1:1500	"	"	"	"	8
" "	1:5000	"	"	"	"	*15
" "	1:5000	"	"	"	"	14
Oxalic Acid.	1:200	"	"	"	"	16
" "	1:200	"	"	"	"	13
Borax.	0.46 grm: 5cc. H_2O	....	"	"	13	1
"	"		"	"	5	0
Iron Sulphate.	2 lbs.: 1 gal	5 cc.	"	8	3	0
" "	" "	"	"	6	6	1
Lead Acetate.	1:200	"	"	1	None.	9
" "	1:200	"	"	None.	"	13
Alum.	1:100	"	"	"	"	17
"	1:100	"	"	"	"	†11
"	1:200	"	"	"	"	11
"	1:200	"	"	"	"	10
Ferric Chloride.	1:200	"	"	"	"	16
" "	1:200	"	"	"	1	11
Potassium Carbonate.	1:100	"	"	"	None.	9
" "	1:100	"	"	"	"	17
" "	1:200	"	"	"	"	10
" "	1:200	"	"	"	"	17

Experiment II—Set 9/23—Examined 10/26, 1914.

CHEMICAL.	Dilution grams to cc. of H_2O	Amount Larvicide used.	Amount manure.	Number dead larvæ.	Number dead pupæ.	Number adults emerged.
Control water.	......	5 cc.	1 oz.	None.	None.	8
" "	......	"	"	"	"	10
Mercuric Chloride.	1:50	"	"	4	9	0
" "	1:50	"	"	4	4	0

*(2 live pupæ). †(Stomoxys calcitrans).

"While these experiments did not furnish a new larvicide, they gave valuable data on the resistance of house fly larvæ to a number of compounds which will be useful in future work.

OUTDOOR EXPERIMENTS WITH IRON SULPHATE AND BORAX.

"On August 3rd, three piles of horse manure containing 200 pounds each (about four bushels) were placed in a row ten feet apart near the horse barn manure pit. One pile received the iron sulphate treatment used successfully on cow manure last year, i.e., 1 gallon of the stock solution to 30 pounds of manure or 6 2/3 gallons for the 200 pounds. The stock solution was made up at the rate of 2 pounds of iron sulphate to 1 gallon of water. The applications were made with a sprinkling can to the surface of the pile. Another pile received 0.31 pounds (amount recommended by Cook, Hutchinson and Scales, loc. cit. p. 24) of commercial borax which was sprinkled over the pile and washed in with 6 2/3 gallons of water. The third pile was used as a control. On August 7th a count was made of a half-bushel sample from each pile with the following results: Iron sul-

phate pile, 400 live larvæ; borax pile, 252 live larvæ; control pile, 215 live larvæ. No water was applied to the check and it had dried out considerably.

"The piles were treated again on August 7th, the amount of larvicide being doubled in each case so that the iron-sulphate pile received 13 1/3 gallons of the stock solution, the borax pile 0.62 pounds washed in with 13 gallons of water, and the control 13 gallons of water. An examination was made again on August 12th with the following results: Iron-sulphate pile, a few pupæ and quite a few young flies; control pile, a few larvæ, pupæ and young flies; borax pile, quite a number of pupæ blackened, elongated and apparently dead and a few young flies. The number of larvæ, pupæ and young flies found was so small that it did not seem worth while to make exact counts. Although the borax pile showed fewer live flies and more dead pupæ than the others, it cannot be said that the number of larvæ and pupæ killed was entirely satisfactory.

"Two other experiments conducted in boxes with open tops covered by wire screen were negatived by what was apparently a bacterial disease and the activities of a hymenopterous parasite, *Spalangia muscidarum* Richardson, which attacked the larvæ or pupæ in the iron-sulphate and borax treated manure as well as in the controls so that very few of the larvæ or pupæ matured.

"Results obtained from experiments last year show that house fly larvæ can be killed if the iron-sulphate is carefully mixed with the manure. The work of the past summer, while not conclusive, indicates that surface treatment of manure piles with iron-sulphate will not result in the total elimination of the larvæ therein contained.

THE EFFECT OF LARVICIDAL DOSES OF IRON SULPHATE AND BLEACHING POWDER ($CaOCl_2$) ON THE GROWTH OF BARLEY.

"An experiment was undertaken last year by Dr. Headlee to determine the effect of manure treated with larvicidal doses of iron-sulphate and bleaching powder upon the growth of barley. Ten large pots were filled with various mixtures of earth, manure and the larvicides and were sown to barley. The crop was gathered when matured and through the kindness of Prof. A. W. Blair, Associate Soil Chemist, dry weights of the plants were determined.

Pot Number.	Fertilizer.	Larvicide.	Dry Weight of Plants in grams.	
			Indiv.	Aver.
1.	No manure.	No treatment.	7.5	9 0
2.	No manure.	No treatment.	10.5	
3.	*Manure.	Fe SO_4—2 lbs. to 30 lbs. manure.	11.0	10.2
4.	"	Fe SO_4—2 lbs. to 30 lbs. manure.	9.5	
5.	"	Fe SO_4—2 lbs. to 15 lbs. manure.	8.0	9.7
6.	"	Fe SO_4—2 lbs. to 15 lbs. manure.	11.5	
7.	"	No treatment.	13.0	10.7
8.	"	No treatment.	8 5	
9.	"	1 lb. bleaching powder to 8 qts. manure.	1.8	1.1
10.	"	1 lb. bleaching powder to 8 qts. manure.	0.4	

Iron sulphate even when used at the rate of 2 pounds to 15 pounds of manure gave better results than when neither manure nor iron sulphate were applied. The pots containing manure alone gave slightly better results than those to which iron sulphate was applied. Bleaching powder had a very disastrous effect on the growth of barley.

Cook, Hutchinson and Scales* found that iron sulphate greatly reduced the bacterial couut in manure. The results of the present experiment do not indicate that the fertilizer value of the manure is greatly harmed.

EXPERIMENTS WITH PYROLIGNEOUS ACID.

"Pyroligneous acid has recently received praise as a fly destroyer from a number of sources. Its champions claimed that it would not ouly destroy the eggs and the larvæ, but that its fumes would even kill the adults. To ascertain the truth of these assertions a number of experiments were undertaken. A barrel of crude pyroligneous acid was kindly furnished through the Vreeland Chemical Company for this purpose. The following test was made June 18th: A quart of undiluted pyroligneous acid was applied to a quantity of manure in a horse stall about which many flies were hovering. In one-half hour practically as many flies were crawling over the manure as before the treatment. The odor of the acid was very strong. It was apparent that pyroligneous acid did not possess any unusual repellant qualities.

"As a further test, five adult flies were captured and placed in a large stoppered bottle into which a rag saturated with undiluted pyroligneous acid had been inserted. A Mason jar containing a water-soaked rag and five flies was used as a check. After 45 minutes exposure, three flies were able to leave the bottle containing pyroligneous acid and two others although wetted by flying against the saturated rag, ultimately flew off. The flies seemed to be slightly inactivated by the fumes, but they recovered when exposed to the air. The flies in the check behaved normally and flew away when the cover was removed from the jar.

"In order to prove whether pyroligneous acid would destroy eggs and larvæ another experiment was made. Two boxes of approximately eqnal size were filled with 1,700 cubic inches of horse manure one day old. An examination was made to see that no large larvæ were present.

"The boxes were placed several feet apart in an exposed position on July 9th. One box was treated with one pint of undiluted pyroligneous acid, applied with a sprinkling can; the other served as a check. Three additional pints of acid were applied on July 11th, 13th and 15th, respectively. Examination was made on July 18th with these results: Check box—28 larvæ and 2 pupæ found in the upper two inches of the manure. Treated box—90 pupæ counted in the upper two inches of the manure. Four or five times as many were found but not counted. They appeared to be normal in every way.

"Since pyroligneons acid failed to repel the adult house fly, or to prevent it from breeding in manure, further experiments were not considered. Recently Cook, Hutchinson and Scales† arrived at similar conclusions.

*Loc. cit., p. 11.

†Loc. cit., p. [illegible]

CONTROL OF THE FLY BREEDING IN HORSE STALLS.

"The stalls at the horse barn are floored with 12-inch planks laid on a foundation of smooth cement. Under these planks, house flies bred in abundance last year, and to prevent a recurrence of this, experiments were conducted with a number of compounds. Nine stalls were chosen for this purpose and the applications were made by removing the stall boards and spreading the larvicides evenly over the cement floor.

"On June 18th, stall 1 received two sixteen-quart pails of dry iron sulphate and stall 2 one-half pail of the same. On June 22nd stall 5 was given two pails of acid phosphate and on June 24th and 25th, stalls 3, 4, 6 and 7 received two pails of acid phosphate each and stalls 8 and 9, two pails each of air-slaked lime. Many *Fannia* larvæ and a few house fly larvæ were found on these days.

"Examination of stalls 1 and 2 was made on June 2nd and they were found to be free from larvæ. July 2nd, stall 1 (iron sulphate) showed no larvæ, stall 2 (iron sulphate) showed a few *Fannia* and one house fly larvæ. In this stall the iron sulphate had largely disappeared. The other stalls were free of larvæ. July 9th, stalls 1, 3, 4, 5, 7 and 9 contained no larvæ. July 15th, stalls 1, 3, 4, 5, 8 and 9 were carefully searched and *Fannia* larvæ were found in stall 5 (acid phosphate) house fly larvæ in stall 8 (air-slaked lime) and *Fannia* and house fly larvæ in stall 9 (air-slaked lime).

"Up to this time only a few larvæ were found in one iron sulphate treated stall which had received but one-half pail of larvicide. Each stall received a pail and a half of iron sulphate on July 16th. This was applied by lifting up the stall boards and throwing the iron sulphate under the ends where it was thought it would pass into solution and disseminate over the cement floor. On July 27th, however, house fly larvæ were found in stall 8 above the point where the iron sulphate had penetrated. On July 30th all the stalls except numbers 1 and 2 received one pail of iron sulphate or about 50 pounds each. Stalls 2, 3, 6 and 9 were examined on August 25th, when house flies were still abundant and only two *Fannia* larvæ were found in stall 2. Fly breeding had been practically eliminated by the use of iron sulphate.

"One hundred pounds or less of iron sulphate properly applied would undoubtedly keep a stall cleared of larvæ through the fly season. The cost would be less than one dollar per stall.

Flight Experiments.

"The number of flies at the pig barn remained fairly constant during the greater part of July and August. As it was certain that all places on the farm where flies could breed in large numbers were practically under perfect control, it was surmised that many must come from outside sources. A number of experiments were made to ascertain how many flies would return to the pig barn when released at points known distances from it. Flies were captured in traps at the pig barn and the number

contained in each was roughly estimated in the following way: A twenty-square-inch piece of wire screen was carefully placed against the trap screen in five or six different places and an average of the number of flies covered by it was taken. With this average and the total area of the traps, the total number of flies could be approximately estimated.

"A trap containing about 3,000 flies was taken to a point 1,715 feet (not quite a third of a mile) southwest of the pig barn on July 22nd. A small quantity of rouge (ferric oxide) was placed on the lid of the trap as it stood upside down. The trap was shaken up and down and with a rotary motion so that the flies were well dusted with the powder. They were liberated at 9:45 A. M. The following results were obtained:

July 24—	1	marked	fly in trap at pig barn.
" "—	1	"	" reported by workman at brooder house.
" 27—	11	"	flies in traps at pig barn.
" "—	1	"	fly in traps at horse barn manure pit.
Aug. 1—	1	"	" " " " " " " "
Total	15		

"Fifteen flies were accounted for out of the entire lot of about 3,000. Of course, it is possible many more returned to the farm and were not seen or caught. The rouge wears off in time so that only a trace persists on the dorsum, or it may disappear from that region entirely, but it always stains the alulæ permanently a pale red color.

"About 11,600 flies were marked and liberated on August 4th. Four thousand of these were marked with rouge and liberated at 11 A. M. from the southwest station (1,715 feet) used for the experiment of July 22nd. Three thousand flies were marked with pulverized chalk and released at 9:50 A. M. from a point 1,715 feet northeast of the pig barn. One thousand six hundred flies marked with a powder composed of carmine and chalk (30 grains of carmine to 1 ounce of chalk) were freed at 11:45 A. M. from a point 1,715 feet northwest of the pig barn. Three thousand flies colored with yellow aniline dye and chalk (120 grains of dye to 1 ounce of chalk) were liberated at 11 A. M. at a distance of 1,715 feet southeast of the pig barn.

"The following flies marked with rouge were accounted for:

August 7th—	4	marked	flies from traps at pig barn.
" "—	1	"	fly " " " horse barn manure pit.
" 9th—	2	"	flies " " " " " " "
Total	7		

"Several flies marked with powdered chalk were seen in the trap at the horse barn manure pit on the afternoon of August 4th, but it is not certain whether they were from the northeast or southeast stations. The yellow aniline dye-chalk preparation gave a poor color which rubbed off easily and when pale could hardly be distinguished from the chalk. When this trap was examined several days afterward none of the flies marked with chalk or aniline dye-chalk could be found and no other flies so marked were ever observed.

"The carmine-chalk mixture gave a good color though not as vivid as the rouge preparation. The flies colored by it, however, were never again seen. This same result came from a preliminary experiment undertaken on July 2nd when about 3,000 flies were marked with carmine-chalk and liberated at the horse barn manure pit. None were recovered. It seems probable that either the carmine or the chalk or both caused the death of these flies or that the color vanished rapidly.

"The last flight experiment was made on August 25th at 3 P. M. with 4,000 rouge-marked flies. They were liberated at the northwest station, 1,715 feet from the pig barn. The following were captured in the traps or seen on the farm:

August	26th—9	marked flies in traps at pig barn.
"	" —3	" " seen " " "
"	28th—2	" " in traps " " "
"	31st—2	" " " " " " "
Total	16	

"A comparison of the longevity of flies marked with rouge in traps with those unmarked showed in the one experiment that the unmarked flies lived one day longer than the marked flies. All but about forty marked flies were dead out of over 1,000 after two days confinement, while a few of the unmarked flies were alive at the end of three days in a trap containing about 1,000. Both lots were fed with moist bread. The flight experiments showed that marked flies may live considerably longer when at liberty. Still, as the above experiment indicated, they probably do not live as long even under natural conditions as the unmarked flies.

"While a very small portion of the marked flies found their way into the traps again, it must be remembered that the pig barn lay in only one of the many directions which marked flies were free to take. This and the fact that many were probably injured by the process of marking will account for the small number that returned.

"The experiments show that flies came from a considerable distance to the pig barn, horse barn and brooder plant. Since the poultry plant borders on the edge of a rather thickly populated area and the pig barn and horse barn are not far distant, it is certain that many flies came from this neighboring territory throughout the season. Although the cow barn is more isolated, undoubtedly many of its flies came from outside sources also.

Why Flies Do Not Breed in Old Compost.

"A close watch was kept for house fly breeding in compost heaps throughout the summer. Those at the greenhouses and one near the pear orchard were under continual surveillance and the benches in the greenhouses were examined from time to time. All of this compost, a mixture of horse manure and straw or cow manure, ensilage and other debris, was left out of doors over winter. No house fly breeding was found in it at

any time. Considerable numbers of house fly larvæ were reported in compost and bench soil last year, but it developed that this compost was made up with fresh manure which, in the warm atmosphere of the greenhouses, offered an excellent breeding place.

"Two striking differences were observable between the old compost and fresh manure heaps. First, compost gave off no perceptible amount of ammonia gas while fresh manure piles gave it off in quantities easily detected; second, compost lacked the characteristic fecal odor of fresh manure. These observations suggested that the pregnant female house fly might be attracted to fresh manure either by the odor of ammonia or by the fecal odor and that the compost was not frequented because of the lack of one or both of these odors.

AMMONIA EXPERIMENTS.

"The attractiveness of ammonia to house flies was tested in the following manner: Two small Hodge fly traps of the type adapted to garbage cans were selected for this experiment. The pans of both were filled level with the top with coarse saw dust, which, it was thought, would simulate horse manure. In one trap, the check; the saw dust was dampened with water while the other received twenty-five drops of concentrated ammonium hydroxide. The traps were placed fifteen feet apart in the pig barn at 5 P. M., August 5th. Flies were abundant at the time. At 10 A. M. the following day, the odor of ammonia could not be detected in the experimental trap, which, however, held three flies. No flies had entered the check trap.

"Another experiment was made with a single small Hodge trap in the pan of which a large piece of ammonium carbonate was placed. The following morning three flies were found in this trap.

"The third experiment was an attempt to induce house flies to oviposit in saw dust from which ammonia was arising. Eight tin pie plates were placed in a row near the horse barn manure pit where house flies' eggs and larvæ could be found at the time (August 5th about 3 P. M.). One hundred and thirty-six grams of coarse saw dust were placed in each. Six pans received 1, 2, 3, 4, 5, and 10 per cent. by weight of ammonium carbonate and enough water to moisten the mixture. Two pans were used as controls and the saw dust was moistened only. The next day at 8:30 A. M., the odor of ammonia had disappeared. There was no evidence that flies had oviposited. The saw dust was moistened daily and on August 10th another examination was made for eggs or small larvæ, but none was found. Flies were not seen on or near the pans at any time.

"If ammonia had been volatilized throughout a longer period in these experiments, the results might have been different. But I believe the attractiveness of ammonia must be feeble, because the experiments were conducted at a time when flies were abundant and in places where they were always present.

EXPERIMENTS WITH MANURE EXTRACTS.

"Human feces derive their fecal odor from two bacterial decomposition products, skatol and indol*, largely the former, but I am not aware that these compounds have been isolated from horse or cow manure. That they exist in horse and cow manure appears certain, however, from the presence of colon bacilli, the indol and skatol forming bacteria, in the alimentary tract of the horse and cow.

"It was desired to see what effect known solvents of skatol and indol would have upon fresh samples of horse manure and to test the reactions of flies to the extracts and residues. Skatol is slightly soluble in water and soluble in alcohol; indol is moderately soluble in hot water and very soluble in ether and alcohol.

"Four two hundred gram lots of fresh horse manure were placed in covered jars. The first lot was macerated in 750 cc. of cold water for thirty hours, then filtered by suction and washed with two liters of water. The second lot received 750 cc. of hot water, was placed on a water bath for thirty hours, then removed, filtered and washed like the first lot. The third lot was given 750 cc. of alcohol for thirty hours, then filtered by suction and washed with two liters of alcohol. The fourth lot received 500 cc. of ether for thirty hours, then was filtered and washed with 500 cc. of ether. The washings from each lot were thrown away. The extracts and residues were kept in covered receptacles until used in the experiments.

"All the extracts possessed a marked fecal odor except the ether extract, which had a very feeble odor, but the alcohol extract was much more odoriferous than the others. The residues all possessed a fecal odor except the alcohol residue, which was practically odorless.

"Equal amounts of the extracts and residues were placed in small Hodge traps and exposed on the south window sills of the laboratory at New Brunswick, July 24th. The results obtained July 27th are here tabulated:

Manure Extracts.

Extract.	Amount in traps.	Number of Flies Caught.	Remarks.
Cold water.	30 cc.	None.	Not all evaporated.
Hot water.	"	1 Muscina stabulans Fall.	" " "
Alcohol *.	"	5 Camptoneura picta Fab. 2 Muscina stabulans Fall. 1 Pollenia rudis Fab. 1 Sarcophaga utilis Aldrich. 1 Calliphora erythrocephala Meig.	" " "
Ether.	"	*None.*	*Evaporated.*

*This was slightly more concentrated than the others.

Manure Residues.

Extracted With:	Amount in Traps.	Number of Flies Caught.
Cold water.	Pan filled.	None.
Hot water.	Pan filled.	None.
Alcohol.	Pan filled.	None.
Ether.	Pan filled.	None.

*Howell—Text Book of Physiology, Philadelphia, 1909, p. 781.

"The alcohol extract was attractive to a larger number of flies than the others because it contained the largest quantity of the compounds which produced the fecal odor. This fecal odor is probably due to two compounds, skatol and indol, known to result from the activities of various colon bacilli, which flourish in the intestinal tract of the horse. Alcohol is a solvent of both of these compounds.

"The manure residues were apparently not present in sufficient quantities to attract flies. Larger amounts would probably show different results. I believe, however, that the alcohol and water residues would be less inviting than the ether residues as the ether appears to remove less of the odor producing compounds.

"It is not clear why house flies did not visit the alcohol extract. Possibly they are not as keen of scent as the species caught. They were never very abundant about the laboratory.

"Skatol and indol deserve a trial as baits for fly traps, although their present cost would probably limit their use to rather weak solutions.

Practical Methods Used to Exterminate Flies.

"All manure from the horse and cow barns was consigned to cement pits every day. These pits were emptied with a few exceptions at least once a week and usually twice or even three times in the case of the cow barn pit. The stalls in the horse barn were treated with iron sulphate as described above. Three horse stalls in a stable near the cow barn were cleaned with some regularity, but undoubtedly bred flies early in the season. They were so constructed that iron sulphate could not be used to advantage under them and larvæ matured in the spaces between the boards until they were cleaned regularly twice a week. The voidings in the pig yards were spread with a rake so that they would dry, a method which gave good results in dry weather but which would not absolutely prevent breeding. Chicken manure, in the one instance in which it was infested by larvæ, was treated with unslaked lime and water which raised the temperature of the mass to 140° F., killing all the larvæ. Whether this destruction was due to the direct action of the lime or to the heat there was no way of determining. This procedure cannot be recommended, as it undoubtedly drives off most of the ammonia from the manure. Sulphur was used for fumigating adult flies in the cow barn and calf barn on a number of occasions. One pound of sulphur to 1,000 cubic feet of space, the formula used last year, was effective in the cow barn, but more was required for the calf barn, which was not nearly so tight.

"The writer feels confident that the control measures greatly reduced the number of flies. Comparatively few could be found at the horse barn or poultry plant even in mid-summer and although the pig barn and cow and calf barns always harbored more than were desired, the trap catches could never be measured by the quarts as they were last year. Just how much this reduction was due to the season or to a difference in the number of parasites, it is, of course, impossible to say."

Report on the Mosquito Work for 1914.

(BY THOMAS J. HEADLEE, PH. D.)

General Outline.

The attention of the Entomologist has been devoted to the study and the prosecution of salt marsh mosquito control, to aiding boards of health as requested to do so, and to general oversight and supplementing the work of the county mosquito extermination commissions.

It must be said at the outset that this record is only approximately complete for, while the writer has a rather complete knowledge of the different broods in that part of the State north of Sandy Hook, his knowledge of the succession to the south is only partial. Still by means of personal inspection trips and by utilizing the records of other observers, a picture of the general conditions in that section of the State can be drawn.

The mosquito breeding season of 1914 has given the drainage systems established on the salt marshes, a very severe test—the most severe for many years.

Early Important Brood.

At the outset the season of 1914 was quite normal, but the unusually long-continued low temperature delayed the development of the early spring brood, which the flooded condition of the salt marsh in early spring usually produces, until it emerged after warm weather set in instead of getting out while the temperature was low enough to prevent biting and quickly to destroy it. As a result of this delay people were annoyed by this brood to some extent.

The species composing this brood were mostly *Aedes cantator* Coq. even as far south as Cape May County. *Aedes cantator* Coq. was practically alone along the coast as far south as Bay Head. South of this point it was associated with *Aedes sollicitans* Wlk.

The early brood came this year from the meadows of Newark Bay and the Hackensack in early May and spread to the north and northwest over the upland to the mountains northwest of Paterson and southwest along their ridges to Summit. In the south, this brood winged its way from the marshes far out into the pines. On May 22nd the writer met members of it in the pines twenty-five miles back from the coast.

As is usually the case, the shut-in meadows in North Jersey were the prolific breeders of this brood. The rains and high tides left such

a quantity of water on them that the outlets were totally inadequate for its discharge. Also, as is usually the case, in early spring the water in these shut-in marshes was almost or quite destitute of fish, which in the more open marshes played so large a part in eliminating this brood. From Barnegat Bay head north to Newark Bay the numbers of mosquitoes escaping, owing to the open character of the marshes and the consequent more rapid drainage and more complete penetration by killifish, was negligible; while from the shut-in marshes of Newark Bay and the Hackensack River the number produced was sufficient to cause some annoyance.

The troublesome part of this infestation appeared in northwestern Hudson, southern and southwestern Bergen, eastern and northern Essex and southern Passaic Counties. Following the mosquitoes along their line of migration to places where they were bred showed rather conclusively that the bulk of the early spring brood, which proved troublesome in the territory above specified, came from the shut-in marshes of the northern part of Newark Bay and of the Hackensack River. It is interesting to note that the line of migration was, as it is usually the case, westward and northwestward and that that portion of Hudson County lying to the east of the Hackensack marshes had scarcely a single mosquito until the middle of July.

In wooded sections this brood remained in evidence for about eight weeks, growing constantly less and less noticeable until at the end of this period specimens were difficult to obtain.

Second Important Brood.

From the issue of the early brood until the 15th of July the number of mosquitoes emerging from the drained salt marsh was negligible and the number coming from the undrained marshes was no greater than normal at that period of the year.

About June 26th the tides began to run high, reached their maximum about July 9th and did not return to low until about July 25th. During much of this time the weather was cloudy and rainy. At first, the large amount of water on the marshes by reason of its low temperature prevented immediate hatching and rendered the growth of the wrigglers very slow. In spite, however, of the low temperature, from one end of the salt marsh to the other, a tremendous brood of wrigglers hatched and started to grow to maturity.

For purposes of considering the development of this enormous brood the marshes may be divided into drained and undrained and each of these classes into the shut-in and open types. On the undrained marsh vast stretches are separated from easy drainage by the slightly higher ground which lies along the banks of the natural creeks and streamlets. These areas, which lie on what would be considered in a drained marsh as open meadow, together with a few more inaccessible places, constitute the shut-in portions of the undrained marsh and forms the vast breeding grounds characteristic of such marshes. The

really open meadow on the undrained marsh is that portion which is covered by every tide that is a little higher than the normal. These shut-in sections of the undrained marsh were full of wrigglers, which were not confined to salt holes but occurred everywhere among the stems of the partly submerged grasses. The killifish were abundant in the creeks and streams of the undrained marshes and were usually plentiful in the salt holes, but proved unable to penetrate the grassy breeding grounds or more inaccessible breeding areas in sufficient numbers to eliminate the developing pest.

On the drained meadow the only shut-in portions are those from which some artificial (roadways, railroads, or fills) or natural (shifting sand beach) barrier prevents the escape of the water. The open meadow is all that portion of the salt marsh where by means of ditching the water normally penetrates at every high tide and escapes at every low water. In contrast with the salt marsh condition of nearly all South Jersey, in Atlantic County from Somers Point to Absecon, in parts of the Barnegat Bay marsh where the drainage system were operating, and from Bay Head to the Arthur Kill the breeding was almost completely eliminated by the killifish which the drainage systems enabled to penetrate the marsh. To some extent, the rapid escape of the water, which the drainage systems of these open meadows permitted, aided in the destruction of this brood. Certain shut-in areas in that portion of the marshes just described which lie in Ocean and Monmouth Counties the killifish failed to penetrate and the mosquito emerged. In similar areas in Middlesex County the County Mosquito Extermination Commission destroyed the breeding at small cost by use of oil.

The drained meadows along the Arthur Kill to the Rahway River are with the exception of those at Woodbridge and Sewaren of the open type and the breeding was almost completely eliminated. At Sewaren and Woodbridge, however, the breeding was too extensive to succumb to oil and a small brood escaped.

From the Rahway River north to the Peddie Street sewer, the meadows are more shut-in, the railroads being mainly responsible. These conditions rendered the control of breeding more difficult and a good sized brood escaped in spite of all efforts to the contrary.

From Peddie Street sewer north along Newark Bay to the Hackensack and Passaic Rivers and up the Hackensack Valley the shut-in character of the marsh becomes very marked. Railroads, roadways, and fills cut it up into basins, the drainage of which is exceedingly difficult. To make matters worse, sewage is poured into several of these basins. The drainage systems, which would serve to remove the water under normal conditions of tide and weather proved wholly inadequate. The use of oil proved impracticable not only because of the enormous area to be covered but because the men in some areas sunk to the hip at every step. From these shut-in marshes and from other undrained or incompletely drained portions of the Hackensack a large brood escaped.

The wrigglers began to produce mosquitoes from about the middle of July. Since a mosquito collecting trip, made from the 15th to the 18th of July covering the whole coast from Jersey City to Port Norris, well indicates the relative abundance of mosquitoes at different points along the coast and brings out rather clearly the effect of the drainage on the number produced, an account of the trip and its findings will be introduced.

The inspection trip began on July 15. Stops of ten minutes were made at regular intervals throughout the trip. The collecting period from West Creek on was much shortened for, with the exception of a few stations in Atlantic county and one in Cape May, the pest was so numerous and blood-thirsty as to render long stops unbearable. Practically all mosquitoes taken from the point of starting to station No. 12, in Newark were *Aedes cantator* Coq., while all taken after that were *Aedes sollicitans* Wlk. At station No. 10, both specimens belonged to the latter species. Inasmuch as it was necessary to drive to Jersey City to make the start, it seemed best to examine mosquito conditions in the back parts of Union and Essex Counties, in the lower part of Bergen, and in the eastern part of Hudson.

The stations and number of salt marsh mosquitoes caught at each are set forth in the following statement:

(1) .5 of a mile northeast of Newmarket on Vail Avenue, no mosquitoes; (2) 1 mile northeast of Plainfield on J. R. Van Ness property, no mosquitoes; (3) South Mountain Reservation, three mosquitoes; (4) Rutherford, no mosquitoes; (5) Paterson Plank Road about half way from western high ground to Secaucus, four mosquitoes; (6) Leonard Gordon Park in Jersey City, no mosquitoes; (7) Park at east end of Jersey City Plank Road, seven mosquitoes; (8) Swift Packing Plant just east of Harrison, fifteen mosquitoes; (9) Davis Memorial Church in Harrison, seven mosquitoes; (10) Frelinghuysen Avenue at Prest-o-lite Works, two mosquitoes; (11) on paved road between Elizabeth and Rahway, no mosquitoes; (12) shore highway just out of Rahway and south of Pennsylvania Railroad, one mosquito; (13) shore highway just west of Sewaren, four mosquitoes; (14) edge of marsh at south end of Perth Amboy, South Amboy highway bridge, no mosquitoes; (15) Shore Road just below Laurence Harbor, no mosquitoes; (16) Keyport, marsh edge at Shore Road, no mosquitoes; (17) near Keansburg, no mosquitoes; (18) marsh edge of south side of north branch of Shrewsbury River, no mosquitoes; (19) Bay Head, four mosquitoes; (20) White's bog near Browns-Mills-in-the-Pines, thirteen mosquitoes; (21) on high road from Lakehurst to Toms River, a little southeast of the former, three mosquitoes; (22) on Shore Road, one and one-half miles south of Toms River, seven mosquitoes; (23) Shore Road just south of Forked River, fifteen mosquitoes; (24) Meadow Road just east of Barnegat, fifteen mosquitoes; (25) Shore Road at West Creek, fifty-four mosquitoes (almost eat you alive); (26) on Shore Road, north side of Mullica River, fifty mosquitoes; (27) on Shore Road in woodland south of Mullica River, thirty-two mosquitoes, (28)

on Shore Road near club house just north of Absecon, fifteen mosquitoes; (29) Light house lawn in Atlantic City, one mosquito; (30) Somers Point, ten mosquitoes; (31) on Shore Road at Marmora, fifty-nine mosquitoes; (32) Shore Road at Avalon Road, fifty mosquitoes; (33) Shore Road at Cold Spring Church, south of Cape May Court House, one mosquito; (34) Green Creek on Delaware Bay shore, thirty mosquitoes; (35) just east of Goshen at edge of the marsh, forty-five mosquitoes; (36) three-fourths of a mile west of Dennisville, near edge of marsh, forty-five mosquitoes; (37) just west of Leesburg, forty-seven mosquitoes; (38) just west of Port Norris, forty-six mosquitoes; (39) high road between Newport and Bridgeton, ten mosquitoes; (40) in Bridgeton, two mosquitoes; (41) in Elmer, no mosquitoes.

1. Mosquitoes found at points between New Brunswick and the park at the Jersey City end of the Newark and Jersey City Plank Road, with the exception of the few taken along the Paterson Plank Road, were much worn and were members of the early May brood.

2. The mosquitoes found in the above park, at Swift's plant and at Harrison were perfectly fresh and, therefore, must have come directly from the adjacent shut-in and imperfectly drained marshes.

3. The mosquitoes found in Newark, Elizabeth, Rahway and Sewaren were of different species but were also fresh and must, therefore, have come from adjacent shut-in and imperfectly drained marshes.

4. The almost total absence of salt marsh mosquitoes from Perth Amboy to Bay Head can be ascribed to nothing other than to fairly satisfactory drainage systems established in the marshes of that territory.

5. The greater number of mosquitoes found near Browns Mills must be attributed to migrations from the Mullica River marshes.

6. The moderate increase in mosquitoes from Lakehurst south to Barnegat must be attributed to less satisfactory drainage of the marshes along the Bay and to its proximity to the undrained marshes below Manahawkin.

7. The comparatively small number of mosquitoes taken between Jersey City and West Creek must be attributed to the more or less perfect marsh drainage that has been established, for no sooner did we pass from territory adjacent to the drained marsh into territory adjacent to the undrained marsh (which we did between Barnegat and West Creek) than the mosquitoes collected increased many times in number. Nor does the number collected tell the full truth, for the mosquitoes were so thick that less than five minutes were spent in collecting. Their bloodthirstiness was too great to be borne.

8. The thinning out in the number collected in Atlantic County occurred in territory adjacent to drained marshes.

The members of this brood which emerged from the undrained and incompletely drained marshes spread themselves through the pines and the farming lands for many miles (thirty or more) back from the coast. The mosquitoes escaping from the drained marshes of Manasquan north to Laurence Harbor were not abundant and gave very slight trouble indeed. Those that escaped from Laurence Harbor to

Sewaren were negligible. Those that came out from Sewaren to Rahway River were few in number and gave little trouble. Those that came out from Rahway River to Peddie Street sewer were considerable in number, but lasted only a short time. Those that came from Peddie Srreet sewer northward were large in number and gave much annoyance. Especially was this true of the *Aedes cantator* Coq. that escaped from the Hackensack.

The brood which came from the marshes beginning at the Rahway River and extending up Newark Bay and the Hackensack River was sufficiently large to sweep over adjacent upland to the mountains. That portion of it from the Rahway River to Peddie Street sewer did not last long or excite much complaint, while that from the shut-in marshes north of Peddie Street sewer and along the Hackensack River especially the latter, lasted a long time and gave great trouble. The issue from the Newark Bay section appeared to trouble Irvington and South Orange particularly, while that from the Hackensack infested western Hudson, southern and southwestern Bergen, eastern and northern Essex and southern Passaic Counties. To a less extent it appeared in eastern Hudson and eastern Bergen.

Later Broods.

The brood, which issued during the latter half of July from the undrained marshes of South Jersey, augmented and replaced by later issues continued extremely troublesome throughout August and September. Even as far north as Bay Head the pest was bad.

The brood, which issued from the Hackensack Valley marshes and spread over western Hudson, southern and southwestern Bergen, southern Passaic, and eastern and northern Essex remained troublesome throughout August. The supply in this region was replenished by later issues. The writer personally observed the emergence of *Aedes cantator* Coq., in large numbers on two different later occasions from the Frank Creek section of the Kearny marsh.

The brood which issued from the shut-in marshes just north of the Peddie Street sewer was replaced at different times from apparently the same source in such a fashion as to keep Irvington and South Orange supplied throughout most of August.

BROODS OF C. PIPIENS LINN AND C. SALINARIUS COQ. FROM SALT MARSHES

From the polluted marshes of northwestern Newark Bay, particularly that portion lying north of Peddie Street, sewer and west of the Central Railroad of New Jersey, which is known as the "Ebling Section" large numbers of *Culex pipiens* Linn., and *Culex salinarius* Coq., escaped, infesting South Newark, including the Weequahic Park section, and a part of North Elizabeth. This infestation was first noted on July 16th.

From the northwestern section of the Frank Creek, part of the Kearny marsh and from the territory lying just north of the Greenwood Lake branch of the Erie Railroad, *Culex pipiens* Linn., and probably also *Culex salinarius* Coq., escaped early in July in sufficient numbers to establish a zone of infestation extending from the marsh edge westward across northwestern Hudson and southwestern Bergen into Essex County to approximately a north and south line running along the western border of Branch Brook Park. The southern border of this infestation appeared to be a line running westward through north Kearny and Riverside to Branch Brook Park. The infestation extended far enough north to trouhle Nutley to some extent.

A number of sewers from the cities on the highland to the eastward empty into that section of the Hackensack marsh which lies along Pen Horn Creek from the County Road to the Paterson Plank Road, converting it into a sewage-polluted marsh. From various parts of this marsh *Culex pipiens* Linn., emerged and made its way into the adjacent cities. No data on the first appearance of *C. pipiens* from this source are available, but the beginning was probably about the middle of July.

These flights of *C. pipiens* from its sewage-soaked salt-marsh breeding places ceased only after they were dried up by weather and additional drainage.

Work Previous to 1914.

Any full discussion of this subject must include a review of the splendid study of the mosquitoes and their habits which preceded the actual work of extermination. Indeed, such a discussion could not fail to include the thorough and fundamental study of methods of control on which the later practical work has been based. But, in view of the fact that this phase of the subject has been rather adequately treated in past reports, it appears desirable merely to recount those facts upon which recent work has thrown new light. These facts all pertain to the practical work of cutting ditches and the treatment of this subject will therefore be limited to that phase.

The number of feet of ditching reported for each of the years to 1913 is only approximate and the actual amount cut is probably less than that listed. The work was largely done under a form of contract (see annual report for 1907) in which the contractor undertook for a lump sum to drain a stated area of marsh, provided he was not required to cut more than a stated maximum number of feet. Under this form of contract the contractor knew the maximum work that could be required to him and probably habitually figured on the maximum number of feet at about so much per foot. The contractor also knew that if he could drain the given area of marsh to the satisfaction of the inspector in charge with a less number of feet than the maximum his profits would be larger.

As a natural and normal result of this form of contract, the number of feet cut on some marshes has been less than the specified maximum.

During the summer of 1913 the attention of the Entomologist was drawn by Mr. C. H. Cranmer and Mr. Theo. A. Corliss, of Manahawkin, to the fact that the ditching was not being cut in that part of the marsh represented by the maps referred to in the contracts * * * Later in the season the Entomologist stopped at Manahawkin and saw Mr. Cranmer. He soon became thoroughly convinced that these gentlemen were right in a part at least of their contention. A thorough personal investigation was then set on foot and the territory covered by Stafford Township Map No. 1, which was supposed to have been ditched and had been paid for, was found to be practically undrained and not a foot of ditching could be discovered in Marsh Elder Island.

When the chief inspector, Mr. Herman H. Brehme's attention was called to the matter, he at first asserted that the maps were incorrect, and after becoming convinced that the maps were substantially right said that a mistake had been made and the ditching put in other territory. The contractor, when his attention was drawn to the matter followed a similar course of explanation.

Examination of the territory having shown that the marsh in dispute was a part of a large natural division with its northward beginning in Union Township, the Entomologist decided to have the entire area examined—all the ditching measured and mapped—for the purpose of seeing wherein the mistake had been made. * * * Accordingly all ditching in Union Township was measured and mapped amounting to 384,169 linear feet of 10x30 inch ditches or their equivalent. The salt marsh in Union Township was covered by three maps. All the salt marsh covered by these maps with the exception of Marsh Elder Island was satisfactorily ditched. On the territory covered by Map No. 1, 186,840 linear feet 10x30 inch ditching was cut; on territory covered by Map No. 2, 110,024 feet; on territory covered by Map No. 3, 87,305 feet. The ditching actually cut in the territory covered by Stafford Township Map No. 1 was found to be 15,105 linear feet of 10x30 inch ditches or their equivalent.

Investigation of the records showed that the ditching work in Union Township and in Map No. 1, of Stafford Township had been done under the following contracts:

1. Contract for ditching marshes of Union Township, Ocean County, dated July 26, 1912	$2,900.00
2. Agreement to drain salt marsh area lying between Gunning River and southern branch of Gunning River, Ocean County, dated September 16, 1912	700.00
3. Agreement to drain salt marsh area lying between Gunning River and northern branch of Gunning River, Ocean County, dated September 16, 1912	500.00
4. Agreement to drain Marsh Elder Island, November 1, 1912	900.00
5. *Contract for ditching salt marshes comprehended in Stafford Township Map No. 1*, dated December 16, 1912	6,300.00
Total	$11,300.00

A careful scrutinizing of the papers connected with this ditching revealed the fact that the contract for ditching the salt marshes of

Union Township carried a maximum of 166,000 linear feet of 10x30 inch ditches or their equivalent and referred to Maps 1 and 2 only. Our measurements show 296,864 linear feet of 10x30 inch ditches or their equivalent in the marsh covered by these two maps. It has seemed impossible for the Entomologist to locate with certainty the territory comprehended in agreements 2 and 3 of the preceding list. It is, however, easy to locare the territory referred to as "Marsh Elder Island" and comprehended in Item No. 4, of the preceding list. It is also easy to locate the territory comprehended by Map No. 1, of Stafford Township.

The facts then are these—the contractor undertook to drain the territory comprehended in Union Township Maps Nos. 1 and 2, providing he was not required to cut more than 162,000 linear feet of 10x30 inch ditches or their equivalent. As a matter of fact the measurements show that he cut 296,864 linear feet of 10x30 inch ditches or their equivalent in this territory. The contractor further undertook to drain two additional pieces of illy defined territory, bordering in one instance the north side of Gunning River and in the other instance the south side of Gunning River. Whether this territory lies wholly in Union Township Map No. 3, or in Maps 2 and 3, the Entomologist is unable to determine. At any rate the drainage of the territory comprehended in Map No. 3, was completed, involving the cutting of 87,305 linear feet of 10x30 inch ditches or their equivalent.

When we take the fact that tbe contractor cut about 384,169 linear feet of 10x30 inch ditching or its equivalent in the marshes of Union Township, as laid down on the maps used, excluding Marsh Elder Island for which he was supposed to receive only $4,100.00 it is clear that something is wrong. It is clear that something is wrong because this means a cost of 1.06 cents a foot as compared with a normal price of about 2.5 cents a foot.

As a matter of fact, however, the contractor received $7,200.00 additional for doing this work and 15,105 linear feet, making the sum of $11,300.00 for cutting 399,274 linear feet of 10x30 inch ditches or their equivalent. This means a cost of 2.8 cents per foot instead of 1.06 cents. The contractor appears to have realized the additional sum of $7,200.00 for this work by getting his money ($900) for the Marsh Elder Island job, without doing any work and his money for the Stafford Township Map No. 1 job, by cutting only 15,105 linear feet of 10x30 inch ditches or their equivalent.

It may be that the real cause for the mistake of the inspector and the contractor lay in the fact that a few years back the marsh section of the division line between Union Township and Stafford Township was changed and made to meander along Fresh Creek into the Gunning river and to follow the Gunning river to Barnegat bay, while the maps followed the earlier survey and took no account of the change. Even this seems hardly sufficient to explain the failure to ditch Marsh Elder Island, which is plainly marked and named on all

the larger survey maps as well as on the Map No. 3 of the Union Township series. The 15,105 feet in territory covered by Stafford Township, Map No. 1 appear to have been cut by the contractor on the following job while he and the inspector were endeavoring to locate themselves.

This mistake resulting in a failure to drain Marsh Elder Island and the salt marsh covered by Stafford Township Map No. 1 was called sharply to the attention of the inspector in charge and the contractor. The latter was requested to drain Marsh Elder Island and to complete the drainage of the territory covered by Stafford Township Map No. 1. At still a later date, January 12th, 1914 the contractor's attention was called to the matter and he was requested to do the work. He simply did nothing and in fact paid no attention to the last communication.

In late January or early February of 1914 the whole matter was laid before the Attorney General and action requested. While the Attorney General had the matter under consideration the contractor suddenly and without notifying this office began, about June 4th, 1914, the work of cutting additional ditching on the territory covered by Stafford Township Map No. 1. He continued this work without asking or permitting any direction from this office until June 23, 1914, when he ceased and removed his gangs. In this period he cut 75,273 linear feet of 10x30 inch ditches or their equivalent, giving the area a little better than one-half the drainage it needed.

This additional work when taken with that already recounted in Union Township and that already on marsh covered by Stafford Township Map No. 1 shows that the contractor cut 474,547 linear feet of 10x30 inch ditches or their equivalent, for which he received the total sum of $11,300.00 or 2.38 cents linear feet.

On July 16th, 1914, the Attorney General issued an order to contractor to complete the drainage of the area covered by Stafford Township Map No. 1. On July 28th information was received from the Attorney General's office to the effect that the contractor requested a conference. The conference was granted and the contractor maintained that he was not to blame for the mistake, for he put the ditches where the inspector instructed him to, that much ditching had been placed under the inspector's orders in territory not under any contract but in territory which would later have had to be ditched, and that the total ditching cut was an amount equal to what could be obtained for the money he had received. The truth of the first contention was borne out by the inspector's written testimony and the correctness of the second and third contentions was proven by the Entomologist's own investigations.

With all these facts in hand the Attorney General ruled on the case as follows:

"On December 16, 1912, Jesse P. Manahan entered into a contract for ditching salt marshes comprehended in Stafford Township, Ocean County, on Map No. 1, for the sum of $6,300.00. The contract provided that he should drain the territory shown on the map, but

should not be required to cut more than 253,000 feet of ditch 30 inches in depth. During the Spring or Summer of 1913, Mr. Manahan actually drained a small part of the area shown on Map No. 1, and cut 15,105 feet of ditching. He was paid the whole contract price, $6,300.00, by virtue of four separate certificates of the Inspector in charge of the work, Herman H. Brehme, each for $1,575.00. In the Summer of 1914, between June 4th and 23rd, after your attention had been called to the matter, and while the matter was under investigation, Mr. Manahan, without being required, did further ditching within the area shown on Map No. 1, and has now drained a considerable part of the area, and cut, altogether, about 90,378 lineal feet of ditch, 30 inches deep. It further appears that Mr. Manahan has done a large amount of draining and ditching outside of, but adjoining the area covered by Map No. 1, amounting, altogether, with the 90,378 feet cut within the area, to fully the 253,000 feet called for by the contract. It further appears that this adjoining area was mosquito breeding swamp needing draining, and that the work on this adjoining area has been for the benefit of the State, and would have been done and paid for had Mr. Manahan not done it. Mr. Manahan states that he supposed that he was doing this work within the area shown on Map No. 1, and that the mistake arose from misapprehension of the township line, and the difficulty of locating the boundaries of the map actually on the ground. He also states that the ditching was done under the direction of the Inspector in charge of the work, Herman H. Brehme, and where directed by him. The letter of Mr. Brehme, enclosed in your letter of the 15th, states that Mr. Manahan put in the ditches as directed by him, and that he personally examined the ditching before certifying that the work contemplated under the contract was completed in accordance therewith. He further says that there was a general mix-up with the township line and lay of the land, and, to make the best of it, under the circumstances, he kept on and cleaned up the worst places for mosquito breeding, as far as the feetage would allow in the contract, and that they were still working in Union Township, when they thought they were doing work in Stafford Township.

"Under these circumstances and facts, I beg to say that, in my judgment, the State has no remedy against Mr. Manahan, or his bondsmen. Mr. Manahan appears to have acted in good faith, and under the direction of the Inspector in charge of the work, and, while the work was not done strictly in accordance with the contract, yet the work was done where both he and the Inspector, acting for the State, supposed the contract called for it. The State received the whole benefit of the work, and, I think, would be bound by the direction and action of the Inspector. It would certainly seem to be impossible, even if legal, to require Mr. Manahan to do additional work, under the contract, and to take advantage of his mistake and not pay him for that work."

This apparently does not dispose of the failure to ditch Marsh Elder Island and that case is still in the hands of the Attorney General.

The experience of the past two years has clearly demonstrated that the form of contract under which the contractor undertook for a lump sum to drain a specified area, providing he cannot be called upon to cut more than a certain specified number of feet, is one for the proper and adequate carrying out much expensive survey work must be undertaken, for if the number of feet necessary is overestimated the State loses money and if underestimated the area fails of complete drainage. It is surely much better simply to ask the contractor to cut a specified number of feet in a given area and to pay him for the actual number of feet cut, neither more nor less. The Entomologist by and with the consent of the Director of the Station has changed the form of contract in such a fashion that the contractor is paid for the number of feet cut,—no more or less.

Summary Work Previous to 1914.

The fundamental investigations of habits and life history and of general methods of control have been completed. The attitude of the public mind has been changed from one of ridicule to one of serious consideration—indeed to one of strong belief in many quarters. A workable law under which the State could proceed with the drainage of the salt marsh had been passed. Care and upkeep of the ditching systems

established on the Hudson, Essex, Union and Middlesex County marshes had been turned over to the mosquito extermination commissions of those counties. In co-operation with the mosquito commission of Atlantic about eight miles of the costal marshes in that county have been freed from mosquito breeding.

WORK OF 1914.

Tabular Statement of the Salt-Marsh Ditching Work From the Beginning to and Including the Year 1914.

PERIOD.	Acres.	Feet of ditching.	Ditching	Cost to the State.	
				Necessary studies and publications.	Administration.
Up to 1907, as reported..	15,851	2,215,524	.....	$11,000.00	....
In 1907, as reported..	10,951	1,505,524	$19,400 00	....	$4,100 00
In 1908, as reported......	6,669	888,650	15,758 00	....	4,242.00
In 1909, as reported...	2,672	365,800	9,917 00	539.00	4,543 00
In 1910, as reported....	4,650	350,000	7,471 00	....	2,528 00
In 1911, as reported....	8,528	712,000	19,650.00	....	5,350.00
In 1912, as reported.....	6,197	1,000,180	21,650 00	....	3,350 00
In 1913, as reported....	7,174	1,564,842	21,580.00	....	4,026.70
In 1914, as reported.....	.....	1,395,840	7,533.86	....	5,213.65

Supervision.

Part salary and expenses of Executive Officer..........	$1,200.00
Salary and expenses of inspectors (Herman H. Brehme, J. S. Obeeny, Henry H Brehme and C. S. Beckwith)............	3,360.51
Advertisng, material, equipment and labor..............	653.14
	$5,213 65

Tabular Statement of 1914 Salt Marsh Ditching Work.

MEADOW.	No. of acres.	No. of feet of 10 x 30 ditches or their equivalent.	Cost—Contract Price	
			Ditching.	Cleaning.
Kearny (Frank Creek Section)....	.....	.....	$1,182.00	....
North Elizabeth..........	.....	50,000	475.00	....
Patcong Creek..........	1,600	136,500	3,000.00	....
Patcong Creek and Great Egg Harbor River..........	2,400	135,101	2,876.86	....
	4,000	321,601	$7,533.86	

In addition to work outlined in the preceding table, Atlantic County has cut 828,367 feet and the Property Owners' Association of Rumson and surrounding places 245,872 feet. A considerable amount of ditching was cut in Hudson County, hut the report of it is not at hand.

Frank Creek.

Frank Creek is a small stream extending northward from the Passaic River for a little less than one and one-half miles at a distance of about one-half mile east of the highland on which Harrison and Kearny are built. At one time it must have been a strong tidal creek, thoroughly draining its section of the meadow. Since that time, however, its channel has been crossed near the mouth by a great railway grade, hearing the four regular tracks of the Pennsylvania Rail-

road, the two regular tracks of the Delaware, Lackawanna & Western Railroad and a number of siding tracks. The creek penetrates this grade through a concrete culvert which has an upstream opening twelve feet wide and six feet high. In this opening are fitted two large tide gates, by means of which the water passes out at low tide.

As one proceeds upstream, one finds its channel crossed just south of the Swift Packing Plant by two railway sidings. The crossing is effected in these instances on wooden culverts that do not appear to impede the flow of water. Just north of the Swift plant it is crossed by the Harrison Turnpike and another railway siding. The Harrison Turnpike crosses it on a concrete culvert which is so narrow as greatly to impede the progress of the water. The railway siding crosses on a wooden culvert and does not materially interfere with the flow. North of this point three railway grades cross its channel, each on a concrete culvert of capacity sufficient to permit rather free flow of the water.

In addition to the interference which the various grades crossing it set up, by the converging of the various railway grades and roadways the creek is called upon to drain a very much larger area than formerly, and to make matters still worse it is expected to carry the raw sewage of Kearny from that town to the Passaic River.

The natural and normal result followed—the channel of Frank Creek became filled with sediment and the sewage spread over sections of the marsh along the banks. This filled-up condition of the creek not only caused the several hundred of acres of salt marsh depending upon Frank Creek for outlet to hold water long enough to turn out far more than its share of the early spring brood of salt marsh mosquitoes, but caused those parts lying adjacent to the banks (involving perhaps fifty acres) to remain wet throughout the breeding season and constantly to throw off *Aedes cantator* Coq. and *Culex pipiens* Linn.

This very serious condition led the station to join with the Common Council of Kearny and the Hudson County Mosquito Extermination Commission in an effort to remedy the trouble. After consultation with the town engineer of Kearny, Mr. H. P. Kriener, and the chief inspector of the Hudson Commission, Mr. William Delaney, the Entomologist drew up a plan for the improvement. This plan included the cleaning of Frank Creek from the point just south of the Swift Packing Plant, where the sidings crossed it, to a point twenty-five feet north of the last railroad culvert. From a point twenty-five feet north of the last culvert the creek was to be cleaned to thirty-six inches below the level of the upper edge of the opening in the north end of the culvert. From this point south the bottom of the finished creek was to exhibit an even and regular fall. From the point of beginning to the Harrison Turnpike the bottom of the creek was to be five feet wide and from that point to the southern end of the improvement eight feet wide.

Knowing that the solid sewage had filled the creek channel it was decided to try to settle the sewage before delivering the water to the cleaned out creek. Two ditches each thirty inches wide and thirty inches deep

were to be cut—one along each side of the creek from the north point of cleaning northward to or almost to the highland. Each ditch was to run along the creek from fifty to one hundred feet from its bank. A dam was to be placed across the creek at a point one hundred and fifty feet north of the last culvert over the creek channel, and the sewage-charged water thereby to be compelled to flow over certain spillways across the settling basin into the ditches.

All this matter was embodied in formal specifications, and proposals advertised for, the understanding being that the work was to be done under the direction of the Common Council of Kearny and the cost to be borne equally by Kearny, the Hudson County Mosquito Extermination Commission, and the Experiment Station. The contract was awarded to Mr. Jesse P. Manahan, of Red Bank, and the work was completed in a satisfactory manner by April 6th, 1914.

The past summer has shown that the settling basin has been only partly successful, much sewage floating across it into the ditches and that the cleaned ditches could not take care of all the water on the several hundred of acres.

It has, however, dried up the sewage soaked areas and prevented the fifty acres before mentioned from continually breeding as was formerly the case. The area which depends upon it as an outlet is entirely too large to be drained into it by gravity. Other outlets must be provided or the water in the distant part of tbe marshes raised by means of a pump.

Little Silver Work.

The occasional appearance of salt marsb mosquitoes in that beautiful summer-home section along the Navesink and Shrewsbury rivers led the property owners of the Rumson Road district to start a movement looking toward the elimination of the last breeding places from which the pest could come.

It was decided that if all breeding places for salt marsh mosquitoes within a radius of four miles from Little Silver railway station were eliminated, the secton already mentoned would be free from further trouble.

The contract for doing this work was awarded to the United States Drainage and Irrigation Company of New York City for the sum of $8,000. The contract provided for a yearly maintenance—the first year to cost $700 and each year thereafter the sum of $1,000 for a period of nine years. The contract provided that any year the Property Owners' Association could void the maintenance clauses.

The Entomologist's attention was called to the matter by Mr. Ira Barrows acting for the association concerned. On June 20th, 1914, Mr. Barrows and Mr. Adams formally requested the Entomologist to examine the ditching and to report on its efficiency, holding that the State could afford to furnish advice when private money was being expended for doing part of the work to which it stood committed. The Entomologist assured Mr. Barrows and Mr. Adams that as soon as the opportunity offered he would cause a careful survey of the territory to be made. Accordingly on Sep-

tember 21st Mr. Charles S. Beckwith began a detailed examination of the territory covered by this contract and on October 22nd completed it.

In general Mr. Beckwith's study showed that the work had been well done. The contractor on being informed in the nature of certain serious faults undertook to remedy them and is at this writing engaged in their correction. All ditches were measured, tested for width and depth, and examined for workmanship. They were plotted on careful maps of the entire district. Mr. Beckwith's report follows:

Report of the Salt Marsh Work Done Under the Little Silver Contract.

MR. CHARLES S. BECKWITH, B. Sc.,

Assistant to the Entomologist in Mosquito Extermination.

"The territory covered by the Little Silver contract includes all the marsh lying along the Navesink with its branches and the Shrewsbury with its branches as far north as the Navesink Highlands. Part of these marshes had already been ditched but the trenches were so badly filled up that cleaning them required as much or more labor as did new work.

"The inspection started on September 21st and continued until October 22nd. The width and depth of all ditches as well as the plan and method of ditching was studied with an object of determining their efficiency. In some cases where there was a large number of short spurs, they were not mapped but their length was added in to make the total number of feet. The general condition of the territory was looked into and all breeding places or likely breeding places were noted.

"After having carefully inspected and mapped the territory, I should say that the drainage work was well done and the mosquito places nearly eliminated. The contractor showed great skill in surveying the ground and finding breeding marsh so that little ditching was wasted, but all dangerous places were drained. I have divided the territory into sections so that it can be described more clearly and fully.

"Section one consists of all the marsh land lying on the banks of Swimming River between the upper bridge at Red Bank and the bridge crossing near the pumping station. This covers about a mile and a half of territory in which there are 52,394 feet of ditching. The marsh on the north side is covered chiefly with salt grass and is drained by a system of parallel ditches, in no case more than 150 feet apart. Around the edge of the marsh is an extra ditch called an upland ditch. The purpose of this is to cut off the numerous small fresh water streams which would normally run out on the marsh and make large pools close to the upland. There is no standing water on this section now, except at the extreme western end where cows are pastured. Here there is water in the hoof prints and mosquito larvæ were found developing in it. To improve the drainage in this field is a difficult matter, because of the impervious texture of the soil. The ditches are already as close as fifty feet and the only thing to do seems to be to deepen the present ditches. Even then this place should be carefully watched. The marsh lying on the south side of the river is a cat-tail area and would not usually be considered a breeding place, but,

because of the water standing on the upland edge, the whole place was drained.

"Section two consists of that marsh lying on Swimming River above the bridge at the pumping station. The river in this section contains less salt and the marsh begins to assume a fresh water character. The first half mile of marsh on the north side of the river is brackish enough to breed the salt marsh varieties and it has been ditched in the same fashion as section one. Seven thousand five hundred and twenty-seven feet of ditching were needed to drain this area. The contractor has had the same difficulties to meet here as he did on the east side of the bridge—a cow pasture in a field where there is little or no seepage. Deepening the present ditches is apparently the best method of improving it, but if more outlets are needed, underdrainage should be resorted to. Above this field, the vegetation indicates a fresh water swamp and it is not likely to breed the *salt marsh mosquitoes. No ditching has been cut in it.*

"Section three consists of the marsh land lying along the creeks running into the north side of the Navesink between the upper bridge at Red Bank and the Navesink Highlands. The first is Nut Swamp Brook, which is a small creek having the same problem as Swimming River on a small scale. It was met in a like manner, ditches being dug as far up as the salt marsh extended, while the remaining swamp is undrained. The second creek is Porin Brook. This goes under the railroad about 200 feet from its mouth and although the first 200 feet is carefully drained, that above the railroad is untouched. No breeding was found there on the day it was inspected, but it has the characteristics of a breeding place, so I place it as dangerous. Ten thousand forty-six feet of ditching were used along these two creeks, but there are three other creeks in this section, none of which are drained. Any of them under unfavorable weather conditions might become breeding places. They are small, however, and can be easily watched.

"Section four consists of the south bank of the Navesink from Red Bank to the Shrewsbury River and from there to the Sea Bright bridge. There are few low spots on the south side of the Navesink between Red Bank and Oceanic. One at Fair Haven was of sufficient importance to be ditched. Just below Oceanic, however, is a large island known as Black Point Sedge. This and the mainland immediately adjacent comprise a large marsh which is partly drained, but which because of interference of owners it was impossible to ditch completely. It is one of the dangerous spots of the territory, especially on the mainland but, as is the case often, it must be watched to find actual breeding. At the junction of the Shrewsbury and the Navesink rivers is a marsh located on Mr. Romain's property. It has been drained and the ditches were in first class condition when inspected. Taking in the two places there are 8,811 feet of ditching in this section.

"Section five consists of all the marsh on the north side of the Shrewsbury between the Sea Bright bridge and Oceanport. This includes many small bits of marsh which were drained before, but the ditches were in bad condition. The object of the contractor in this place seemed to be to

follow these old ditches, no difference how crooked they were and to effect a drainage through the old openings. New ditches were put in wherever necessary, making a total of 36,004 feet for this section. Many of the cleaned ditches are shallow and the bottoms uneven. The openings of the ditches just north of the club house are all choked up with sea weed, which is washed in heavily at this point, making the cost of maintenance much higher than it normally would be. The contractor deserves great credit for cleaning out all the creeks and old ditches extending far back on the upland. This work was not called for in the contract, but it helped control many fresh water kinds of mosquitoes, especially of the malarial sort. One small place that was missed is at the head of Parker Creek, opposite the residence of Mr. Bell. It is a small piece of salt grass marsh and three or four parallel ditches would put it out of harm's way. The large cat-tail area at the head of this creek is not likely to send out any salt marsh mosquitoes.

"Section six includes that marsh on the south side of the Shrewsbury and its south branches between Oceanic and Low Moor. This again is a combination of old and new ditches and, while the new ones are carefully placed, the old ones seem to be dug in a hit or miss style, making a poor looking result. The ditches that open directly into the river between Blackberry Creek and Pleasure Bay are subject to a wave action which fills the openings with sand. The upkeep here is rather more than is justified for a permanent piece of work, and the contractor should correct the fault. There is a very small piece of marsh just north of Mr. Beck's property at Low Moor which has not been drained, thereby causing considerable criticism. One ditch would drain the entire place and stop all danger of breeding. This section is by far the largest and 124,613 feet of ditching were used in its drainage.

"Section seven takes in the islands in the Shrewsbury. They are low and need only ditches to the holes where breeding is common in summer. Six thousand four hundred and twenty-seven feet were sufficient to do this thoroughly.

"I have mentioned that several doubtful places should be carefully watched, but this applies in a sense to every section of the marsh. It is impossible to say definitely whether mosquitoes will or will not breed in a certain area. The State and the counties engaged in such work have found that the only way to be sure a salt marsh is not breeding is to have an inspector on it all the time. This man must be one who understands mosquito work and must be able to get over all the territory within a week after high tides. Of course the contractor will maintain an inspection, but if the association is to get the benefit of its expenditure, it should have a representative who will see that there is no breeding of mosquitoes within the drained area.

"This inspection work should be carried on between March 1st and October 1st, including the entire breeding season.

"The total number of feet of ditching in the territory amounts to 246,822, which, at $8,000, makes the price per foot about 3.2 cents. The

average price is about 2.5 per foot, but the scattered character of this marsh must have made its ditching more expensive.

"The marsh is now free from breeding pools and all ordinary breeding in the grass except as mentioned on Swimming River. There is no reason why the territory along the Navesink and Shrewsbury rivers should not be entirely free from salt marsh mosquitoes."

North Elizabeth Meadow Work.

For two breeding seasons the Entomologist has observed that a very considerable amount of breeding occurs on that part of the Union County meadow which lies east of the Central Railroad of New Jersey and south of Bound Creek. This breeding occurred between the ditches already constructed in water which lay on the surface long enough to produce the adult mosquitoes.

The present ditches are not only very far apart (500 feet) but so long that the water in them has little movement at any time. The meadow is an open one and but for these conditions should be as free from breeding as any well trenched meadow.

Believing that the practical solution of the problem lay in more ditches and in better outlets the Experiment Station offered to pay one-half the cost of improving the northwest corner of this section. The Union County Mosquito Extermination Commission accepted the offer and undertook the work. The plan was to cut two wide ditches paralleling the Central Railroad of New Jersey, each forty inches wide, running from Bound Creek southward to the oyster road ditch in one instance and into oyster creek in the other. The rest of the ditching wa sto be cut as 10x30 inch ditching between the old ditches and to drain into the new wide north and south channels.

The total ditching amounted to 50,000 linear feet of 10x30 inch ditches or their equivalent.

The contract was awarded to Mr. Jesse P. Manahan of Red Bank for the sum of $950, and was completed in a satisfactory manner. The bid of 1.9 cents per foot was notable as being the lowest received for this work for several years.

Patcong Creek Work.

The work of the Mosquito Extermination Commission of Atlantic County and the Experiment Station had, before the station was ready to cut any ditching this season, eliminated the breeding places from Absecon to Somers Point—a distance of almost eight miles. This fact taken with the additional fact that salt marsh mosquitoes bred any considerable distance north of a given point rarely infest that point, led the chief inspector of that commission to request that further ditching placed in Atlantic County by the station be cut in marshes westward of Somers Point. As this seemed the best way to obtain the maximum protection for the money expended, the station decided to place its ditching on Patcong Creek and Great Egg Harbor River.

Accordingly on July 21st, 1914, a contract for cutting 120,000 linear feet of 10x30 inch ditches or their equivalent on the meadows of Patcong Creek was awarded to the United States Drainage and Irrigation Company.

The salt marsh from Somers Point to the new roadway across Patcong Creek is so frequently swept by the tide that breeding apparently does not occur. Along both sides of Patcong Creek from the new road almost to Steelmansville bridge the breeding was found to be very prolific. The Patcong Creek marsh had been under observation for some time before the ditching began and by the time the gangs were on the ground the breeding spots had nearly all been indicated by white stakes.

The Patcong Creek section extends about three miles upstream from Great Egg Harbor River, the marsh averaging from 800 to 1,000 feet wide on each side of the creek. There are a few small creeks and very few of the "farmers' ditches." A border of high ground about seventy-five feet wide runs along the banks of the creeks and ditches, behind which the marsh is from six to twelve inches lower. The poor drainage of the lower portions of the marsh permitted only the growth of coarse sedge grasses while the higher parts supported a good crop of salt hay. Breeding pools are few in number and the breeding observed took place in the water surrounding the partially submerged sedge. High tides sweep over the meadow, and after all had run off that would readily do so, two or three inches would remain among the sedge until it had time to escape by seepage or evaporation. Tides, which under ordinary meadow conditions would destroy the developing brood by current and killifish, here failed to do their work, because the sedge stems protected the wrigglers from the current and screened them from the fish. Even when the water was drained away the wrigglers lived as long as the soil protected from the sun by the grass remained damp. For periods of forty-eight hours the wrigglers have been observed to persist in the moist mud needing during this time only the return of the water to continue life and development.

Owing to these rather unusual conditions it was necessary to drain the Patcong Creek marsh in such a fashion as to remove all water from the surface. At first an effort was made to drain by running ditches through the low spots but it quickly appeared that regardless of care in placing ditches there was always some spot more than 100 feet away in which the water stood for days. Parallel ditching was resorted to to overcome this difficulty and proved very satisfactory.

Mr. Charles S. Beckwith was appointed inspector in charge and carried the work through in a very satisfactory manner. Ditching began on the east side of the creek, just above the new road and continued up stream almost to Steelmansville Bridge. Eighty-one thousand two hundred and sixty-eight linear feet or their equivalent were cut in this side of the creek. The gangs were then transferred to the west side and beginning on the first breeding marsh worked down stream until the 120,000 feet ran out.

Just before the work contemplated in this job was completed it was decided to complete the expenditure of $3,000 in Atlantic County during the fiscal year and the contracting company was asked whether it would cut

an additional 16,500 linear feet of 10x30 inch ditches or their equivalent in Patcong Creek marshes at the same rate per foot and according to same specifications. Being promptly assured of the contractor's willingness the job was awarded.

Within the time limited the contractor finished the work comprehended in the regular contract in a highly satisfactory manner. At the end of this job the additional ditching was cut. Although warned against doing so, the contractor cut 1,270 feet more than the total. Including these extra feet, 56,502 linear feet of 10x30 inch ditching or its equivalent was cut in the marshes along the west side of Patcong Creek.

It should be said in passing that at the request of the chief inspector of the Atlantic County Commission a certain amount of very short spurring was left for his men to do when they went on the area for the purpose of filling all holes with sods.

All told, 137,770 linear feet of 10x30 inch ditches have been cut in the salt marshes of Patcong Creek at a cost of $3,000, relieving 1,600 acres from mosquito breeding.

Patcong Creek and Great Egg Harbor River Work.

Owing to the fact that the necessary steps preliminary to advertising and awarding of contract for drainage in the salt marses of Bergen County could not be completed before the close of the present fiscal year the sum of two thousand eight hundred and seventy-six dollars and eighty-six cents ($2,876.86) became available for further ditching on these areas in Atlantic County.

On October 20th, 1914, a contract for cutting 135,701 linear feet of 10x30 inch ditches, or their equivalent, in the salt marshes of Patcong Creek and Great Egg Harbor River was awarded to the United States Drainage and Irrigation Company. The work began on the west side of Patcong Creek where the previous job had left off and continued along its border until all the marsh on the west side of the creek and north of the new road was drained. From Patcong Creek the gangs began the drainage along the east side of Great Egg Harbor River proceeding upstream. All told, more than 134,431 linear feet of 10x30 inch ditches, or their eqnivalent, were cut in this location. The work relieved 2,400 acres from mosquito breeding.

It should be said at this point that the contractor asked to have the extra 1,270 feet inadvertently cut during the former job accepted as a part of this contract, and that the request, appearing to be a reasonable one, was granted.

Hackensack Valley Inspection Work.

The conviction that the Hackensack Valley threw off several troublesome broods of mosquitoes in the breeding season of 1913 induced the Entomologist to make plans for watching it during the season of 1914. Mr. Henry H. Brehme was sent over the entire marsh area in the fall of 1913 and his findings indicated that while not the entire marsh surface

was likely to breed, there were places located in all sections which would be likely to produce mosquitoes. For the reason that the funds of the Experiment Station were inadequate to meet the calls made upon it and that the territories of Hudson, Essex, and Union Counties were invaded by these swarms, the aid of these counties was sought and obtained.

It was agreed that Essex County should contribute the services of Mr. Wilbur Walden, one of its deputy chief inspectors and an engineer by training, and one regular inspector, that Hudson County should contribute two inspectors and Union one, and that the Experiment Station should devote the time of its regular inspector, Mr. Henry H. Brehme. It was understood that Mr. Walden should be in charge of the work, and that he should be assisted by Mr. Brehme. It was also understood that a report of progress made in each week of work should be submitted to the chief inspectors of the counties concerned and to the Entomologist.

The inspection began on April 13th and continued for one month. In this time, with the exception of a small section of marsh in Harrison lying between the Pennsylvania Railroad and the Passaic River, the entire Hackensack Valley salt marsh was examined.

Nearly all the breeding found by Mr. Walden was that of *Aedes cantator* Coq., but a few samples of *A. sylvestris* were taken. Breeding was found in the 3rd, 4th, 8th, 9th, 10th, 11th, 12th, 13th, 14th, 15th, 16th, 17th, 18th, 19th, 21st, 22nd, and 23rd districts* out of a total of 27. In some cases the breeding covered the whole area of certain sections in a given district but usually it was confined to limited portions of the different sections.

Mr. Walden's reports having demonstrated that the Hackensack Valley salt marsh was likely to prove a very prolific source of mosquitoes, it seemed only wise to keep it under observation throughout the breeding season. In this way it was hoped much of the breeding might be eliminated with oil and the facts necessary to proper drainage accumulated. Accordingly, a force composed of inspectors from Essex and Union Counties headed by Mr. Henry H. Brehme covered the entire valley every ten days or two weeks. The following cases of breeding were discovered.

DISTRICT No. 1.—Area between the Hackensack River and the Passaic River extending from the Newark Bay northward to the Newark and Jersey City Plank Road.

May 12—Light breeding of *A. cantator* larvæ found in 15 small holes on the south side of the Newark and New York branch of the Central Railroad of New Jersey.

May 20—Light breeding of *A. cantator* larvæ found in 5 holes south of Central Railroad of New Jersey.

June 2—Scattered breeding of *C. pipiens* larvæ found in 2 old cans near the Chemical Company plant south of the Newark and Jersey City Plank Road.

*The districts referred to are described on succeeding pages.

June 10—Light breeding of *A. sollicitans* larvæ found in a number of pools north of the Newark and New York branch of the Central Railroad of New Jersey.

July 6—Heavy breeding of *A. cantator* larvæ found in overgrown ditch north of the Newark and New York branch of the Central Railroad of New Jersey.

July 29—Scattered breeding of *A. cantator* larvæ found in five small holes on the south side of the Newark and New York branch of the Central Railroad of New Jersey. Heavy breeding of *A. cantator* larvæ found in a overgrown ditch on the north side of the Newark and New York branch of the Central Railroad of New Jersey.

August 22—Light breeding of *A. sollicitans* larvæ found in an overgrown ditch on the north side of the Newark and New York branch of the Central Railroad of New Jersey.

DISTRICT NO. 2.—Area between the Hackensack River and the Passaic River extending from he Newark and Jersey City Plank Road northward to the Jersey City branch of the Pennsylvania Railroad.

May 12—Light breeding of *A. cantator* found in ten holes along Arlington Water Company's pipe line and in holes along telegraph poles south of Jersey City branch of Pennsylvania Railroad.

May 20—Scattered breeding of *A. cantator* larvæ found in five small holes east of Passaic Avenue and three pools about 300 feet west of the Hackensack River south of the Jersey City branch of the Pennsylvania Railroad.

June 10—Scattered breeding of *A. cantator* larvæ found in three holes along the Arlington Water Company's pipe line and in six holes along the telegraph poles south of the Pennsylvania Railroad east of Passaic Avenue. Scattered breeding of *C. pipiens* larvæ was found in one barrel along edge of dumping ground.

June 24—Scattered breeding of *A. cantator* larvæ was found in holes along old railroad ties and double row of telegraph poles south of Jersey City branch of Pennsylvania Railroad and scattered breeding of *A. cantator* larvæ found in two holes along the Arlington Water Company's pipe line.

July 6—Light breeding of *A. cantator* larvæ found in cattails on the west side of Passaic Avenue. Heavy breeding of *A. cantator* and *A. sollicitans* larvæ found in holes, ditches and foot prints south of the Jersey City branch of the Pennsylvania Railroad. Light breeding of *A. cantator* larvæ found in seventeen holes along the Arlington Water pipe line. Scattered breeding of *C. pipiens* larvæ found along the edge of the dumping gronnd.

July 17—Light breeding of *A. cantator* larvæ and pupæ found in the cattails along the south side of the Jersey City branch of the Pennsylvania Railroad east of Passaic Avenue. Scattered breeding of *C. pipiens* larvæ found along the edge of garbage dump north and south of the Arlington Water Company's pipe line for about 250 feet. Light breeding of *C. pipiens* and *A. sylvestris* larvæ found in eight pools on the garbage dump just north of the Newark and Jersey City Plank Road.

July 29—Scattered breeding of *A. cantator* larvæ found in six sign post holes south of the Jersey City branch of the Pennsylvania Railroad east of Passaic Avenue. Scattered breeding of *C. pipiens* and *C. salinarius* larvæ found in four holes along the Arlington Water Company's pipe. Scattered and heavy breeding of *C. pipiens* larvæ and pupæ found along edge of garbage fill at the Arlington Water Company's pipe line.

August 11—Scattered breeding of *A. cantator* larvæ found in six sign post holes south of the Jersey City branch of the Pennsylvania Railroad east of Passaic Avenue. Light and heavy breeding of *C. pipiens* larvæ and pupæ found in two holes and at the dumping ground along the Arlington Water Company's pipe line. Scattered breeding of *C. pipiens* larvæ found along the edge of the dumping ground and in four pools just north of the Newark and Jersey City Plank Road.

August 22—Light breeding of *C. pipiens* found in one pool about 400 feet north of the Newark and Jersey City Plank Road. Light and heavy breeding of *C. pipiens* larvæ and pupæ found in six holes and for 200 feet west of the garbage fill along the Arlington Water Company's pipe line.

September 5—Light breeding of *C. pipiens* larvæ found along the edge of the garbage fill at the Arlington Water Company's pipe line. Scattered breeding of *C. pipiens* larvæ found along the garbage fill just north of the rendering plant.

September 15—Scattered breeding of *C. pipiens* larvæ found in one hole and along garbage fill at the Arlington Water Company's pipe line.

October 9—Scattered breeding of *C. pipiens* larvæ found along the edge of the garbage fill at the Arlington Water Company's pipe line.

DISTRICT No. 3, SECTION A.—*Area between the Jersey City branch of the* Pennsylvania Railroad and Delaware, Lackawanna and Western Railroad, extending from the Hackensack River westward to the junction of the grades of these lines.

May 12—Very little breeding; only about a dozen *A. cantator* larvæ found.

May 20—One acre, light breeding of *A. cantator* larvæ found and 10 per cent. pupæ found at the Dioxygen sign board.

July 6—Heavy breeding of *A. cantator* and *A. sollicitans* larvæ found in blind ditches and at nine sign boards.

July 17—Heavy breeding of *A. cantator* larvæ and pupæ found in post holes at ten sign boards.

July 29—Heavy breeding of *A. cantator* larvæ found at 11 sign post holes. Heavy breeding of *A. cantator* and *C. pipiens* larvæ found along the old Jersey City water pipe line west of the Hackensack River.

August 11—Light breeding of *C. pipiens* found along the old Jersey City water pipe line west of the Hackensack River.

August 21—Light breeding of *C. salinarius* larvæ found in a ditch at the Remington sign board and in depressions at the Remington sign board. Light breeding of *C. pipiens* larvæ found in seven holes along the old Jersey City water pipe line west of the Hackensack River.

September 7—Scattered breeding of *C. pipiens* larvæ found along the old Jersey City water pipe line.

District No. 3, Section B.—Area between old branch of Erie Railroad, Hackensack River, and the Thirty-Second Street line of the Pennsylvania Railroad.

May 12—Light breeding of *A. cantator* larvæ in all stages in almost every pool and hole west of the Hackensack River to the railroad spur.

June 10—Scattered breeding of *A. cantator* larvæ found in scattered tree stump holes.

July 6—Heavy breeding of *A. cantator* and *A. sollicitans* larvæ found in every overgrown ditch and tree stump hole.

July 29—Scattered *A. cantator* larvæ found in a few tree stump holes.

District No. 3, Section C.—Area between the Delaware, Lackawanna and Western Railroad and the old branch of the Erie Railroad, extending from the Hackensack River westward to the Belleville Turnpike.

May 20—Heavy breeding of *A. cantator* larvæ and 80 per cent. pupæ in ditch 1,500 feet long and 10 feet wide about 1,200 feet west of Hackensack River and light breeding of *A. cantator* larvæ and 15 per cent. pupæ in fonr pools and a blind ditch 20 feet long at the Coward Shoe sign.

June 10—Light breeding of *A. cantator* larvæ found at the Vulvulix and Kabo sign boards east of the junction of the Harrison Turnpike and the Delaware, Lackawanna and Western Railroad.

June 24—Light breeding of *A. cantator* larvæ found in three sign post holes and a ditch at the Gray and Henry sign and one pool at the Mosquito Tavern.

July 6—Heavy breeding of *A. cantator* and *A. sollicitans* larvæ found in every ditch and sign post hole on this section.

July 17—Light breeding of *A. cantator* larvæ and pupæ found at the Kabo sign and in 100 feet of ditch at the Kelley Loan Company sign.

July 29—Light breeding of *C. pipiens* and *C. salinarius* larvæ found in a wide ditch on the west side of the levee along the Hackensack River. Light breeding of *A. cantator* larvæ found in a blind ditch at the second signal tower of the Delaware, Lackawanna & Western Railroad and at the Haig & Haig sign board.

August 12—Light breeding of *C. pipiens* larvæ found along the north side of Belleville Turnpike in pools west of the Mosquito Tavern.

August 24—Scattered breeding of *C. pipiens* larvæ found in three holes along the Delaware, Lackawanna & Western Railroad 700 feet east of the Harrison Turnpike.

District No. 3, Section D.—Area between the Harrison Turnpike and the Belleville Turnpike, extending from the junction of the Harrison and Belleville Turnpike westward to the Thirty-Second Street line of the Pennsylvania Railroad.

July 7—Scattered breeding of *A. cantator* larvæ found just east of Thirty-Second Street line of Pennsylvania Railroad.

July 18—Heavy breeding of *A. cantator* larvæ and pupæ found in sign post holes.

District No. 3, Section E.—Area between the Delaware, Lackawanna & Western Railroad, the Thirty-Second Street line of the Pennsylvania Railroad, and the Harrison Turnpike.

June 11—Scattered breeding of *C. pipiens* larvæ found in a ditch at Roe and Conover sign board east of Kearny Junction.

June 24—Light breeding of *A. cantator* larvæ found in seven holes at the sign boards and *C. pipiens* larvæ in two holes at the Jap-a-lac sign board.

July 30—Heavy breeding of *C. pipiens* larvæ and pupæ found over about one and one-half acres just east of where the Thirty-Second Street line of the Pennsylvania Railroad runs over the Delaware, Lackawanna & Western Railroad.

August 12—Heavy breeding of *A. cantator* and *C. pipiens* larvæ and pupæ found. One acre at the Chambers sign board.

August 24—Light breeding of *C. pipiens* larvæ found at the sign hoard east of where the Pennsylvania Railroad runs over the Delaware, Lackawanna & Western Railroad.

District No. 4, Section A—Area between the Belleville Turnpike and the Arlington Water Company's pipe line extending northward from the old Newark and Paterson branch of the Erie Railroad to the present Newark and Paterson branch of the Erie Railroad.

May 12—Very little breeding of *A. cantator* larvæ found.

July 7—Light breeding of *A. cantator* larvæ found over this whole area.

August 12—Ligbt hreeding of *C. pipiens* and *C. salinarius* larvæ found in the cattails east of the third culvert.

District No. 4, Section B.—Area between the Delaware, Lackawanna & Western Railroad, the Thirty-Second Street line of the Pennsylvania Railroad and Harrison Turnpike, extending from the junction of the Thirty-Second Street line of the Pennsylvania Railroad and Harrison Turnpike westward to the upland.

May 12—Heavy breeding of *A. cantator* larvæ and pupæ and many adults on the wing west of the Old Fish Road.

May 23—Heavy hreeding of *A. cantator* larvæ and about 75 per cent. pupæ were found between Swift's Railroad spur and Frank Creek south of the Swift Plant, which covered about two acres.

June 11—Scattered breeding of *A. cantator* larvæ fonnd in ten-inch ditcb at the Clysmic sign board and one hole north of the Remington Typewriter sign board.

July 7—Light breeding of *A. cantator* and *C. sollincitans* larvæ in every hole and depression west of the Old Fish Road.

July 30—Light breeding of *A. cantator* larvæ found in six holes west side of the Old Fish Road.

District No. 4, Section C.—Area between Harrison Turnpike and old Newark and Paterson branch of the Erie Railroad extending from the Thirty-Second Street branch of the Pennsylvania Railroad westward to Frank Creek.

May 12—Scattered breeding of *A. cantator* larvæ found east of Frank Creek.

July 7—Light breeding of *A. cantator* larvæ found over this whole area.

July 18—Heavy breeding of *A. cantator* larvæ and pupæ found over this whole section.

July 30—Scattered breeding of *A. cantator* larvæ found in cattails eastward from the first culvert east of Frank Creek and in a pool just west of the Thirty-Second Street line of the Pennsylvania Railroad.

August 12—Light breeding of *C. pipiens* and *C. salinarius* larvæ found in the cattails for 2,000 feet along the old Newark and Paterson branch of the Erie Railroad. Scattered breeding of *C. pipiens* larvæ found in pools along the Harrison Turnpike.

August 24—Scattered breeding of *C. pipiens* larvæ found in the cattails for 150 feet just west of the Arlington Water Company's pipe line.

District No. 4, Section D.—Area between Harrison Turnpike and the old Newark and Paterson branch of the Erie Railroad extending from Frank Creek westward to the upland.

May 12—Only an occasional *A. cantator* larvæ found.

May 25—Only seven *A. cantator* larvæ found at Woburn Degreasing Company's plant.

June 11—Scattered breeding of *A. cantator* larvæ found in a pool on the north side of the Woburn Degreasing Company's plant.

June 24—Scattered breeding of *C. pipiens* larvæ found in a ditch on the west side of the Woburn Degreasing Company's plant.

July 7—Scattered breeding of A. cantator larvæ found in a ditch and in the cattails west of the Woburn Degreasing Company's plant.

July 18—Scattered and heavy breeding of *A. cantator* throughout.

July 30—Light and heavy breeding of *C. pipiens* larvæ and pupæ found in the cattails west of the Woburn Degreasing Company's plant to the dumping ground at the upland.

District No. 4, Section E.—Area between the old Newark and Paterson branch of the Erie Railroad and the present Newark and Paterson branch of the Erie Railroad extending from Frank Creek westward to the upland.

May 12—Only an occasional *A. cantator* larva found.

District No. 4, Section G.—Area between the old Newark and Paterson branch of the Erie Railroad and the new Newark and Paterson branch of the Erie Railroad extending from the Arlington Water Company's pipe line westward to Frank Creek.

May 12—Scattered to heavy breeding of *A. cantator* larvæ and 90 per cent pupæ found from Frank Creek eastward for about 1,000 feet.

July 7—Light breeding of *A. cantator* and *C. pipiens* larvæ found over this whole section.

July 18—Scattered and heavy breeding of *A. cantator* larvæ and pupæ found over this whole section.

DISTRICT No. 5, SECTION A.—Area between the Newark and Paterson branch of the Erie Railroad and the Duke Street sewer extending from Frank Creek westward to the upland.

July 7—Light breeding of *A. cantator* larvæ found in the cattails and scattered breeding of *C. pipiens* larvæ found in cattails along the north side of the Newark and Paterson branch of the Erie Railroad.

July 30—Scattered breeding of *C. pipiens* found in the cattails north of the Newark and Paterson branch of the Erie Railroad.

August 12—Light breeding of *C. pipiens* larvæ found in cattails 75 feet north of the Newark and Paterson branch of the Erie Railroad.

DISTRICT No. 5, SECTION B.—Area between the Duke Street sewer and the Bergen Avenue sewer extending from the junction of the Duke Street and Bergen Avenue sewers westward to the upland.

July 7—Scattered breeding of *A. sylvestris* larvæ found along the upland north of Tappan Street in cattails.

July 30—Light breeding of *C. pipiens* larvæ found in the Bergen Avenue sewer.

DISTRICT No. 5, SECTION C.—Area between the Bergen Avenue sewer and Frank Creek, extending from the Newark and Paterson branch of the Erie Railroad westward to the upland.

June 24—Twelve *C. pipiens* egg boats found in a ditch south of Kearny Gun Club house.

July 7—Light breeding of *C. pipiens* and scattered breeding of *A. sylvestris* larvæ found in a ditch at woodland north of the Kearny Gun Club house.

July 20—Light breeding of *C. pipiens* larvæ found in a ditch at the woodland north of the Kearny Gun Club house.

DISTRICT No. 5, SECTION D.—Area between the new Newark and Paterson branch of the Erie Railroad and the New York and Greenwood Lake branch of the Erie Railroad, extending from the Belleville Turnpike westward to Frank Creek and the upland.

May 13—Light breeding of *A. cantator* larvæ and pupæ found between Frank Creek and the second culvert east of Frank Creek, north of the Erie Railroad and scattered *A. cantator* larvæ were found about 800 feet west of the Belleville Turnpike south of the New York and Greenwood Lake branch of the Erie Railroad.

May 25—Heavy breeding of *C. pipiens* larvæ found along the edge of the dumping ground south of the New York and Greenwood Lake branch of the Erie Railroad.

June 12—Scattered breeding of *C. pipiens* larvæ found along the edge of the dumping ground south of the New York and Greenwood Lake branch of the Erie Railroad.

June 24—Scattered breeding of C. pipiens larvæ found at the edge of the dumping ground south of the New York and Greenwood Lake branch of the Erie Railroad.

July 7—Light breeding of *C. pipiens* larvæ found at the edge of the dumping ground south of the New York and Greenwood Lake branch of the Erie Railroad. Scattered breeding of *A. sylvestris* larvæ found in hoof prints and holes south of the Oakwood Avenue dumping ground.

July 20—Light breeding of *C. pipiens* larvæ found along the edge of the dumping ground south of the New York and Greenwood Lake branch of the Erie Railroad. Light breeding of *A. slyvestris* larvæ and pupæ in holes south of the Oakwood Avenue dumping ground.

July 30—Slight breeding of *A. sylvestris* larvæ found in pools and cattle hoof prints south of the Oakwood Avenue dumping ground along the upland.

August 4—Light breeding of *A. cantator* and *C. pipiens* larvæ and pupæ found over three-fourths of the section.

August 12—Scattered breeding of *C. pipiens* found along the edge of the dumping ground south of the New York and Greenwood Lake branch of the Erie Railroad.

September 8—Light breeding of *C. pipiens* found along the edge of the dumping ground south of the New York and Greenwood Lake branch of the Erie Railroad.

District No. 6, Section A.—Area between the Belleville Turnpike and the New York and Greenwood Lake branch of the Erie Railroad extending from the junction of the Newark and Paterson and the New York and Greenwood Lake branch of the Erie Railroad westward to the Belleville Turnpike.

July 8—Scattered to light breeding of *A. cantator* and *A. sylvestris* larvæ found along the south side of the New York and Greenwood Lake branch of the Erie Railroad.

July 20—Scattered breeding of *A. cantator* larvæ found which covers about five acres.

District No. 6, Section B.—Area between the Belleville Turnpike, Thirty-Second Street line of the Pennsylvania Railroad and the New York and Greenwood Lake branch of the Erie Railroad, extending from the old railroad spur westward to the Newark and Paterson branch of the Erie Railroad.

July 6—Heavy breeding of *A. cantator* larvæ found in very many old tree stump holes.

District No. 6, Section C.—Area between the Thirty-Second Street line of the Pennsylvania Railroad and the New York and Greenwood Lake branch of the Erie Railroad, extending from the Hackensack River westward to the old railroad spur.

July 6—Heavy breeding of *A. cantator* and *A. sollicitans* larvæ found in old tree stump holes.

July 20—Light breeding of *A. cantator* larvæ found which covers about one-half an acre.

DISTRICT No. 7, SECTION A.—Area between the New York and Greenwood Lake branch of the Erie Railroad and the Belleville Turnpike, extending from the junction of the New York and Greenwood Lake branch of the Erie and the Belleville Turnpike westward to the upland.

May 14—Scattered breeding of *A. sylvestris* larvæ found along upland north of the Arlington Company's plant.

June 12—Heavy breeding of *C. pipiens* larvæ and pupæ found along the Arlington Company's fill. Scattered breeding of *C. pipiens* and *Anopheles* larvæ found in two pools 7x25 and 6x30 feet east of the Arlington cemetery.

June 25—Heavy breeding of *C. pipiens* larvæ and pupæ found along the Arlington Company's fill.

July 8—Light breeding of *C. pipiens* larvæ found in a ditch and along the Arlington Company's fill. Scattered breeding of *C. pipiens* larvæ found in the two pools east of the Arlington cemetery.

July 20—Light breeding of *C. pipiens* larvæ found along the edge of Arlington Company's fill. Light breeding of *C. pipiens* larvæ found in a ditch 100 feet long south of the Arlington Cemetery.

July 31—Scattered breeding of *C. pipiens* and *C. salinarius* larvæ found along the Arlington Water Company's pipe line 300 feet east of Saw Mill Creek. Heavy breeding of *C. pipiens* larvæ and pupæ found in the cattails east of the Arlington Company's ash-fill for 500 feet. Scattered breeding of *C. pipiens* larvæ found along the edge of the Arlington Company's ash-fill. Light breeding of *C. pipiens*, *C. salinarius* and *A. sylvestris* larvæ found in a ditch 75 feet long south of the Arlington cemetery. Scattered *Anopheles* larvæ found in one pool on the east side of the Arlington cemetery.

August 13—Heavy breeding of *C. pipiens* larvæ and pupæ found wherever water was found. Light breeding of *C. pipiens* larvæ and pupæ found at telegraph pole No. 96 east of Saw Mill Creek on the north side of the Belleville Turnpike.

August 25—Scattered and heavy breeding of *C. pipiens* larvæ found along the edge of the Arlington Company fill. Scattered breeding of *C. pipiens* larvæ found in the lily pond on the east side of the Arlington cemetery.

September 8—Heavy breeding of *C. pipiens* larvæ found in the cattails and along the Arlington Company's fill. Scattered breeding of *C. pipiens* larvæ found in the lily pond on the east side of the Arlington cemetery.

September 19—Scattered breeding of *C. pipiens* larvæ found along the edge of Arlington Company's ash-fill.

DISTRICT No. 7, SECTION B.—Area between the New York and Greenwood Lake branch of the Erie Railroad and Saw Mill Creek, extending from the Hackensack River westward to the Belleville Turnpike.

May 13—Scattered *A. cantator* larvæ breeding just west of the Hackensack River.

June 12—Scattered breeding of *A. cantator* larvæ found in two ditches and at the Major Cement Company's sign west of the Hackensack River.

June 25—Light breeding of *A. cantator* larvæ found in the ten-inch ditches just west of the Hackensack River.

July 8—Scattering and heavy breeding of *A. cantator* and *A. sollicitans* larvæ found over an area of about 30 acres west of the Hackensack River.

August 13—Scattered breeding of *A. cantator* larvæ found in a ditch at switch No. 20 and in a pool at signal tower No. 42.

DISTRICT NO. 8, SECTION A.—Area between the Belleville Turnpike and Meadow Road east of Astor Avenue, extending from Saw Mill Creek westward to the upland in Arlington.

June 13—Scattered breeding of *C. pipiens* and *Anopheles* larvæ found in four pools along the Arlington Water Company's pipe line north of the Belleville Turnpike.

June 25—Scattered breeding of *C. pipiens* larvæ found in three small pools along the old Jersey City water pipe line west of Saw Mill Creek.

July 9—Scattered breeding of *A. sylvestris* larvæ found south of Meadow Road east of Astor Avenue, which covers about two acres.

July 20—Scattered breeding of *A. cantator* and *A. sylvestris* larvæ and pupæ found south of Meadow Road which covers about ten acres. Heavy breeding of *C. sylvestris* larvæ and pupæ found in pool on north side of Belleville Turnpike west of Saw Mill Creek.

July 31—Scattered breeding of *C. pipiens* and *A. sylvestris* larvæ found along the edge of the upland south of the Meadow Road east of Astor Avenue.

August 13—Scattered breeding of *C. pipiens* larvæ found in depressions south of the Meadow Road east of Astor Avenue along the upland.

August 25—Scattered breeding of *C. pipiens* larvæ found in the large pool on the north side of the Belleville Turnpike opposite the Arlington Cemetery gate.

DISTRICT NO. 8, SECTION B.—Area between the Meadow Road east of Astor Avenue and the Boonton branch of the Delaware, Lackawanna & Western Railroad, extending from the southern branch of Kingsland Creek westward to the upland in Kingsland.

July 8—Heavy breeding of *A. sylvestris* larvæ and pupæ found about 800 feet north of Meadow Road east of Astor Avenue along the upland. Light breeding of *A. cantator* and *A. sylvestris* larvæ found in cattails east of the Delaware, Lackawanna & Western Railroad shops.

July 21—Light breeding of *A. cantator* and *A. sylvestris* larvæ found in the cattails east of the Delaware, Lackawanna & Western Railroad shops.

July 31—Scattered breeding of *C. pipiens* larvæ found in one pool about 800 feet north of the Meadow Road east of Astor Avenue along the upland.

August 13—Light breeding of *C. pipiens* larvæ and pupæ found in the cattails at the foot of Gast Avenue.

August 25—Scattered breeding of *C. pipiens* larvæ found in a pool east of the foot of Gast Avenue.

DISTRICT No. 8, SECTION C.—Area between Saw Mill Creek and Kingsland Creek, extending from the Hackensack River westward to the Meadow Road east of Astor Avenue.

DISTRICT No. 8, SECTION D.—Area between Kingsland Creek and the Boonton branch of the Delaware, Lackawanna & Western Railroad, extending from the contact of the two westward to the northern branch of Kingsland Creek.

May 22—Six small holes had breeding of about one-half a dozen *A. cantator* larvæ and pupæ going on in them.

July 9—Light breeding of *A. cantator* and *A. sylvestris* larvæ found just south of the Delaware, Lackawanna & Western Railroad embankment.

July 21—Light breeding of *A. cantator* larvæ found for about 700 feet east of the northern branch of Kingsland Creek.

DISTRICT No. 8, SECTION E.—Area between Kingsland Creek and the Boonton branch of the Delaware, Lackawanna & Western Railroad Company, extending westward from the Hackensack River to the contact of the two.

DISTRICT No. 9, SECTION A.—Area between the Boonton branch of the Delaware, Lackawanna & Western Railroad and the Jersey City water pipe line, extending from the Hackensack River westward to the upland in Kingsland.

May 14—About one dozen small *A. cantator* larvæ found breeding along the water pipe line.

May 22—About one-half dozen *A. cantator* larvæ found along the Delaware, Lackawanna & Western Railroad embankment.

July 9—Light breeding of *A. cantator* and *A. sylvestris* larvæ found along the north side of the Delaware, Lackawanna & Western Railroad embankment and the south side of the Jersey City water pipe line about 1,800 feet west of the Hackensack River.

August 26—Heavy breeding of *A. cantator* and *A. sylvestris* found in cattails along the Jersey City water pipe line for a distance of 1,000 feet.

DISTRICT No. 9, SECTION B.—Area between the Jersey City water pipe line and the embankment area, extending from the Hackensack River and Berry's Creek westward to the upland in Kingsland and Lyndhurst.

May 14—About one dozen *A. cantator* and *A. sylvestris* larvæ found in cattails along the upland.

May 22—Light breeding of *A. cantator* and *A. sylvestris* in cattails along the upland.

June 3—Scattered *A. cantator* and *A. sylvestris* larvæ and pupæ found in two small holes along the upland.

June 15—Heavy breeding of *A. cantator* and *A. sylvestris* larvæ found on the north side of the Jersey City water pipe line at the small woodland west of the Hackensack River. There was light breeding of *A. cantator* and *A. sylvestris* larvæ found going on on the south side of the water pipe line.

June 26—Scattered breeding of *A. cantator* larvæ found along the north side of the Jersey City water pipe line for a distance of 300 feet.

August 1—Scattered breeding of *C. pipiens* larvæ found in cattails along the upland.

August 26—Heavy breeding of *A. cantator* and *A. sylvestris* larvæ found in cattails along the Jersey City water pipe line for a distance of 1,000 feet.

DISTRICT NO. 9, SECTION C.—Area between the dike at Lyndhurst and the dike at Rutherford, extending from Berrys Creek westward to the upland at Lyndhurst and Rutherford.

May 22—Light breeding of *A. cantator* and *A. sylvestris* larvæ in two pools and a ditch a foot wide about 800 feet north of the Kingsland Brick Plant.

July 9—Light breeding of *A. cantator* and *A. sylvestris* larvæ found in overgrown ditch about 400 feet north of the Kingsland Brick Works.

August 26—Light breeding of *A. cantator* and *A. sylvestris* larvæ found in the cattails and overgrown ditch about 800 feet north of the Kingsland Brick Works. Light breeding of *C. pipiens* larvæ found along the edge of garbage fill south of the main line of the Erie Railroad.

DISTRICT NO. 9, SECTION D.—Area between the diked area and the main line of the New York, Lake Erie & Western Railroad, extending from Berry's Creek westward to the upland in Rutherford.

June 3—One *C. pipiens* egg boat found in an old cistern just south of the Columbia Button Works east of Meadow Road.

DISTRICT NO. 10, SECTION A.—Area between the New Jersey and New York branch of the Erie Railroad and the upland in East Rutherford, extending from the main line of the New York, Lake Erie & Western Railroad northward to the Paterson Plank Road.

June 26—Scattered breeding of *C. pipiens* larvæ found at dumping ground south of Ciser's ice house.

June 27—Light breeding of *C. pipiens* larvæ and pupæ found along the north and south sides of Stanley Street in the cattails. Scattered breeding of *C. pipiens* larvæ found in a ditch on the east side of the Hackensack car barn.

July 9—Light breeding of *C. pipiens* larvæ found along the edge of dumping ground south of Ciser's ice house.

July 22—Light breeding of *C. pipiens* larvæ and pupæ found along the edge of the dumping ground south of Ciser's ice house.

August 3—Light breeding of *C. pipiens* larvæ found in one pool on the east side of the Hackensack trolley car barn. Light breeding of *C. pipiens* larvæ found in cattails at the dumping ground south of Ciser's ice house.

August 14—Scattered breeding of *C. pipiens* larvæ found in a sewer ditch east of the dumping ground south of Ciser's ice house.

DISTRICT No. 10, SECTION B.—Area between Berry's Creek and the New York and New Jersey branch of the New York, Lake Erie & Western Railroad, extending from the main line of the New York, Lake Erie & Western Railroad northward to the Paterson Plank Road.

May 19—Scattered breeding of *A. sylvestris* larvæ found just east of the New Jersey and New York branch of the Erie Railroad.

June 16—Light breeding of *A. cantator* larvæ found in 25 sign post holes north of the junction of the main line and the New Jersey and New York branch of the Erie Railroad.

July 9—Heavy breeding of *A. cantator* and *A. sylvestris* larvæ found going on in 96 sign post holes and in two small depressions.

July 10—Heavy breeding of *A. cantator* and *A. sylvestris* larvæ and pupæ found in a ditch south of the Paterson Plank Road 500 feet east of the New Jersey and New York branch of the Erie Railroad.

August 3—Scattered breeding of *A. cantator* larvæ found at the sign boards north of the junction of the New Jersey and New York branch of the main line of the Erie Railroad. Scattered breeding of *A. cantator* and *A. sylvestris* found in an overgrown ditch east of the Hasselhunes coal pockets.

DISTRICT No. 10, SECTION C.—Area between the Hackensack River and Berry's Creek, extending from the new canal northward to the Paterson Plank Road.

June 17—Light breeding of *A. cantator* larvæ found in ditch about 3 by 300 feet along the Paterson Plank Road, 500 feet west of the Hackensack River.

July 10—Scattered breeding of *A. cantator* larvæ found over about ten acres of meadow. Light breeding of *A. cantator* larvæ found in a ditch about 400 feet long, 600 feet west of the Hackensack River. Light and heavy breeding of *A. sylvestris* larvæ in every pool found in the woodland.

August 5—Scattered breeding of *C. pipiens* and *C. salinarius* larvæ found in a ditch along the Paterson Plank Road 500 feet west of the Hackensack River.

DISTRICT No. 10, SECTION D.—Area between the Hackensack River and Berry's Creek, extending from the main line of the New York, Lake Erie & Western Railroad northward to the new canal.

June 16—Light breeding of *A. cantator* larvæ found in 42 sign post holes west of the Hackensack River and north of the main line of the Erie Railroad.

June 26—Scattered breeding of *A. cantator* larvæ and pupæ found in 13 sign post holes west of the Hackensack River north of the main line of the Erie Railroad.

July 9—Scattered and heavy breeding of *A. cantator* larvæ found in 227 sign post holes and in depressions which cover about one and one-half acres.

DISTRICT No. 10, SECTION E.—Area between the Hackensack River and Berry's Creek south of the main line of the New York, Lake Erie & Western Railroad.

June 16—Light breeding of *A. cantator* larvæ and pupæ found which covers an area of about two acres just east of the place where the main line of the Erie Railroad crosses Berry's Creek; and scattered breeding of *A. cantator* larvæ were found in 10 sign post holes west of the Hackensack River.

July 9—Light breeding of *A. cantator* larvæ found going on in 150 sign post holes west of the Hackensack River and light breeding of *A. cantator* larvæ found just east of where Berry's Creek flows under the main line of the Erie Railroad which covers about two and one-half acres.

August 3—Scattered breeding of *A. cantator* larvæ found in an overgrown ditch at telephone poles Nos. 107 and 108.

District No. 11, Section A.—Area between the Hackensack River and the upland in Secausus, extending from the Paterson Plank Road southward to the main line of the New York, Lake Erie & Western Railroad.

District No. 11, Section B—Area between the old iron works road and the county road, extending from the Paterson Plank Road southward to the New York, Lake Erie & Western Railroad.

July 15—Heavy breeding of *A. cantator* and *C. sollicitans* larvæ and pupæ found in holes and depressions about 400 feet north of where the New York, Lake Erie & Western Railroad crosses County Avenue.

July 27—Scattered breeding of *A. cantator* larvæ found in holes and depressions 400 feet north of where the New York, Lake Erie & Western Railroad crosses County Avenue.

District No. 12, Section A.—Area between the County Road and the Erie and Susquebanna Railroads, extending from the Paterson Plank Road southward to the Secaucus Road.

May 18—Scattered breeding of *A. cantator* larvæ found which covers an area of about three-fourths of an acre east of the schoolhouse along the County Road.

May 27—Scattered breeding of *C. pipiens* larvæ found in a ditch about 300 feet long, about 700 feet north of the Secaucus Road east of the New York, Susquehanna & Western Railroad.

June 6—Scattered breeding of *C. pipiens* found in a pool about 400 feet north of the Secaucus Road west of the New York, Susquehanna & Western Railroad, and heavy breeding of *C. pipiens* larvæ found in barrel at 171 Tounele Avenue.

June 19—Scattered breeding of *C. pipiens* larvæ found in two pools north of the Secaucus Road, west of the New York, Susquehanna & Western Railroad and scattered breeding of *C. pipiens* larvæ found just south of the Homestead Station, east of the New York, Susquehanna & Western Railroad.

July 1—Light breeding of *C. pipiens* larvæ found in small pools 700 feet north of the Secaucus Road along the New York, Susquehanna & Western Railroad. Scattered breeding of *A. cantator* larvæ found at the sign boards north of the Secaucus Road, east of Pen Horn Creek. Light breeding of *A. cantator* found along the south side of the Paterson Plank Road

for 800 feet in a ditch which was cut from Koch's Hotel to Pen Horn Creek. Light breeding of *A. sylvestris* and *C. pipiens* larvæ found in cattails about 500 feet north of the Secaucus Road east of the New York, Susquehanna & Western Railroad.

July 14—Light breeding of *A. cantator* larvæ and pupæ found along the west side of the New York, Susquehanna & Western Railroad in the cattails south of the Jagee & Beldis coal pockets. Light breeding of *C. pipiens* and *A. sylvestris* larvæ found in the cattails about 1,200 feet north of the Secaucus Road east and west of the New York, Susquebanna & Western Railroad. Light breeding of *C. pipiens* larvæ were found in the cattails and an open ditch just east of Koch's Hotel on the south side of the Paterson Plank Road.

July 25—Light breeding of *C. pipiens* larvæ found in the cattails for 500 feet south of the Thirty-Second Street Line of the Pennsylvania Railroad west of the New York, Susquehanna & Western Railroad. Scattered breeding of *C. pipiens* larvæ found along the edge of the garbage pile on the north side of the Secaucus Road just east of the Pen Horn Creek. Light breeding of *A. cantator* larvæ found in the cattails along the soutb side of the Paterson Plank Road east of Koch's Hotel. Scattered breeding of *A. cantator* larvæ found in the ditch just west of Koch's Hotel.

August 7—Heavy breeding of *C. pipiens* larvæ and pupæ found west of the clay pits and in the cattails surrounding the old dumping ground south of the Jagee & Bellis' coal pockets. Scattered breeding of *C. pipiens* larvæ found in cattails for 300 feet soutb of the Thirty-Second Street Line of the Pennsylvania Railroad, west of the New York, Susquehanna & Western Railroad. Scattered breeding of *C. pipiens* larvæ found in the cattails south of Koch's Hotel, on the south side of the Paterson Plank Road. Light breeding of *C. pipiens* eggboats and larvæ found in a ditch and cattails between Homestead and Tyler Park east of the New York, Susquehanna & Western Railroad.

August 19—Light breeding of *C. pipiens* larvæ found in a ditch beween eastern and western tracks of the New York, Susquehanna & Western Railroad soutb of the Homestead Station. Heavy breeding of *C. pipiens* larvæ found in two pools 400 feet west of the New York, Susquebanna & Western Railroad north of Secaucus Road. Scattered breeding of *C. pipiens* larvæ found in small pools about 600 feet south of the Homestead Station east of the New York, Susquebanna & Western Railroad. Heavy breeding of *C. pipiens* larvæ and pupæ found in the Pen Horn Creek at the Tbirty-Second Street Line of the Pennsylvania Railroad.

September 4—Scattered breeding of *A. cantator* larvæ found in the cattails on the south side of the Paterson Plank Road for 100 feet east of Kocb's Hotel. Scattered breeding of *C. pipiens* found in tbree pools on the north side of the Secaucus Road. Scattered breeding of *C. pipiens* larvæ found between the eastern and western tracks of the New York, Susquehanna & Western Railroad, south of the Homestead Station.

September 25—Light breeding of *C. pipiens* larvæ found in Pen Horn Creek on the north side of the Secaucus Road at the Thirty-Second Street Line of the Pennsylvania Railroad.

October 12—Scattered breeding of *C. pipiens* larvæ found in four pools on the north side of the Secaucus Road.

District No. 12, Section B.—Area between the County Road and the Erie and Susquehanna Railroads extending from the Secaucus Road southward to County Line.

May 18—Scattered *A. cantator* larvæ breeding nortb of buildings at Lundy's Lane.

May 27—Scattered breeding of *A. sylvestris* larvæ and pupæ in a ditch about 25 feet north of Lundy's Lane east of the New York, Susquebanna & Western Railroad.

June 19—Scattered breeding of *C. pipiens* larvæ found in two ditches south of tbe Secaucus Road and light breeding of *C. pipiens* larvæ in a ditch along tbe north side of the County Line west of the New York, Susquehanna & Western Railroad.

July 1—Light breeding of *A. cantator* and *C. pipiens* larvæ found along Secaucus Road from dumping ground westward to Pen Horn Creek. Scattered breeding of *C. pipiens* larvæ found in two pools at Weigan's Lane, one pool at Lundy's Lane and one culvert under the New York, Susquehanna & Western Railroad.

July 14—Heavy breeding of *C. pipiens* larvæ found along Weigan's Lane in two pools. Heavy breeding of *C. pipiens* found in cesspool overflow at Weigan's Lane. Heavy breeding of *C. pipiens* larvæ found in a pool 3x30 feet on the east side of the New York, Susuehanna & Western Railroad, 200 feet south of the Secaucus Road. Heavy breeding of *C. pipiens* larvæ found in the cattails between Lundy's Lane and County Line, for 800 to 1,000 feet. Scattered breeding of *A. cantator* and *C. pipiens* found in the scattered cattails on the north side of the County Line.

July 25—Heavy breeding of *C. pipiens* larvæ and pupæ found in pool at Weigan's Lane and Secaucus Road. Scattered breeding of *C. pipiens* larvæ found at edge of garbage fill on the south side of Weigan's Lane. Heavy breeding of *C. pipiens* larvæ and pupæ found in a pool on the north side of the garhage fill at the Secaucus Road and the New York, Susquehanna & Western Railroad. Scattered breeding of *C. pipiens* larvæ found in two pools 200 feet north of Lundy's Lane. Light breeding of *C. pipiens* larvæ found in cattails south of Lundy's Lane and along the County Line west of the New York, Susquehanna & Western Railroad.

August 7—Light breeding of *C. pipiens* larvæ found in three pools at Weigan's Lane. Scattered breeding of *C. pipiens* larvæ found under four culverts along the New York, Susquehanna & Western Railroad from Secaucus Road to Lundy's Lane. Scattered breeding of *C. pipiens* larvæ found in two pools on the north side of Lundy's Lane. Scattered breeding of. *C. pipiens* larvæ found in the cattails on the west side of the New York, Susquehanna & Western Railroad and the north side of County Line south of Lundy's Lane.

August 19—Light breeding of *C. pipiens* larvæ and pupæ found in a ditch and a pool at the edge of the dumping ground along Weigan's Lane. Light breeding of *C. pipiens* larvæ found under the second railroad culvert

north of Lundy's Lane. Scattered breeding of *C. pipiens* larvæ found in a pool 150 feet south of Lundy's Lane west of the New York, Susquehanna & Western Railroad.

September 4—Scattered and heavy breeding of *C. pipiens* larvæ and pupæ in three pools and one gutter along Weigan's Lane. Heavy breeding of *C. pipiens* larvæ and pupæ found in the cattails on the south side of the Secaucus Road east of the Pen Horn Creek. Heavy breeding of *C. pipiens* larvæ and pupæ found at the old dumping ground on the south of the Secaucus Road east of Pen Horn Creek. Heavy breeding of found in a pool and ditch at the garbage dump just south of the Paterson Line sewer. Scattered breeding of *C. pipiens* larvæ found under two culverts of the New York, Susquehanna & Western Railroad, two pools just south of Lundy's Lane and in the gutter along the north side of the County Line.

September 21—Scattered breeding of C. pipiens larvæ found in three pools along the edge of the old dumping ground on the south side of the Secaucus Road.

District No. 13, Section A.—Area between the Public Service Power Plant and Pen Horn Creek, extending from the Hackensack River eastward to the New York and Greenwood Lake branch of the Erie Railroad.

May 15—About one dozen *A. cantator* larvæ found in a few holes.

June 16—Scattered breeding of *A. cantator* larvæ found just north of the Public Service Power Plant in two holes.

July 2—Scattered breeding of *A. cantator* and *A. sollicitans* larvæ found in three pools just north of the Public Service Power Plant.

July 15—Light breeding of *A. cantator* and *A. sollicitans* larvæ found in six pools along the row of telegraph poles on this section.

July 27—Scattered breeding of *A. sollicitans* larvæ found in six holes on the north side of the Public Service ash-fill.

August 20—Heavy breeding of *C. pipiens* larvæ and pupæ found in a ditch on the Public Service property.

District No. 13, Section B.—Area between the New York and Greenwood Lake branch of the Erie Railroad and the Boonton branch of the Delaware, Lackawanna & Western Railroad, extending from the junction of the New York and Greenwood Lake branch of the Erie Railroad and the Boonton branch of the Delaware, Lackawanna & Western Railroad northward to Pen Horn Creek.

June 8—Light breeding of *A. sollicitans* larvæ found in a pool just north of the New York and Greenwood Lake branch of the Erie Railroad and in a blind ditch about ten feet long about 100 feet south of Pen Horn Creek.

July 2—Scattered breeding of *A. cantator* and *A. sollicitans* larvæ found in an overgrown ditch 100 feet south of Pen Horn Creek.

July 15—Light breeding of *A. cantator* and *A. sollicitans* larvæ found in 33 pools and in an overgrown ditch about 100 feet south of Pen Horn Creek.

July 27—Scattered breeding of *A. sollicitans* larvæ found in eight holes and an overgrown ditch 100 feet south of Pen Horn Creek.

August 8—Scattered breeding of *A. sollicitans* larvæ found in one pool and an overgrown ditch about 100 feet south of Pen Horn Creek.

DISTRICT NO. 13, SECTION C.—Area between Pen Horn Creek and the Thirty-Second Street Line of the Pennsylvania Railroad extending northward from the Hackensack River to the New York and Greenwood Lake branch of the Erie Railroad.

July 2—Scattered breeding of *A. cantator* and *A. sollicitans* larvæ in overgrown ditch 600 feet east of Thirty-Second Street Line of Pennsylvania Railroad. Light breeding of *A. cantator* and *A. sollicitans* larvæ found in sign post holes 200 feet east of Thirty-Second Street Line of the Pennsylvania Railroad.

July 15—Light breeding of *A. cantator* and *A. sollicitans* larvæ found in post holes and in overgrown ditch 600 feet east of the Thirty-Second Street Line of the Pennsylvania Railroad.

DISTRICT NO. 13, SECTION D.—Area between Pen Horn Creek and the Thirty-Second Street Line of the Pennsylvania Railroad, extending from the New York and Greenwood Lake branch of the Erie Railroad to the Boonton branch of the Delaware, Lackawanna & Western Railroad.

May 15—Light breeding of *A. cantator* larvæ in holes along telegraph poles west of Delaware, Lackawanna & Western Railroad.

July 2—Light breeding of *A. cantator* and *A. sollicitans* larvæ found in 12 sign post holes at the Alabastine and Monticello signs.

July 15—Light breeding of *A. cantator* and *A. sollicitans* larvæ found in sign post holes and in the cattails south of the Alabastine and Monticello sign boards.

July 27—Heavy breeding of *A. cantator* and *A. sollicitans* larvæ found in sign post holes and in the cattails south of the Monticello sign board.

August 8—Scattered breeding of *A. sollicitans* larvæ found in cattails and sign post holes at the Monticello sign board.

August 20—Scattered *C. salinarius* eggboats in a pool near Little Snake Hill.

DISTRICT NO. 13, SECTION E.—Area between the Boonton branch of the Delaware, Lackawanna & Western Railroad and the main line of the New York, Lake Erie & Western Railroad, extending from the New York & Greenwood Lake Railroad freight spur northward to Pen Horn Creek.

June 8—Scattered *A. sollicitans* found along railroad spur south of Pen Horn Creek.

St June 20—Light breeding of *A. sollicitans* larvæ found along railroad
found south of Pen Horn Creek.
of. C. —Scattered breeding of *A. cantator* and *A. sollicitans* larvæ found
York, Susq. of Erie Railroad spur soutb of Pen Horn Creek.
Line south of Heavy breeding of *A. cantator* and *A. sollicitans* larvæ and
August 19— along the old Erie Railroad spur. Heavy breeding of *A.*
ditch and a po *sollicitans* larvæ and pupæ found in pools along the east
Light breeding nton branch of the Delaware, Lackawanna & Western

August 8—Light breeding of *C. pipiens* larvæ and pupæ found in pools on the west side of the old Erie Railroad spur south of Pen Horn Creek.

DISTRICT No. 13, SECTION F.—Area between main line of the New York, Lake Erie & Western Railroad and County Road extending from the New York & Greenwood Lake Railroad freight spur northward to Pen Horn Creek.

June 8—Scattered breeding of *C. pipiens* larvæ found in sewage overflow north of the New York & Greenwood Lake branch of the Erie Railroad spur.

June 20—Scattered breeding of *C. pipiens* larvæ found in sewage overflow north of the New York & Greenwood Lake Railroad spur.

July 2—Light breeding of *C. pipiens* larvæ found in sewage overflow north of the New York & Greenwood Lake branch of the Erie Railroad freight spur.

July 14—Light breeding of *C. pipiens* found in cattails along the north side of County Road 600 feet east of Pen Horn Creek.

July 15—Scattered breeding of *C. pipiens* larvæ found in sewage overflow north of the New York & Greenwood Lake branch of the Erie Railroad freight spur.

July 25—Scattered breeding of *C. pipiens* larvæ found in a pool 600 feet east of Pen Horn Creek.

July 27—Heavy breeding of *C. pipiens* larvæ and pupæ found in sewage north of the New York & Greenwood Lake branch of the Erie Railroad freight spur.

August 8—Scattered breeding of *C. pipiens* larvæ found in the sewage north of the New York & Greenwood Lake branch of the Erie Railroad spur.

August 20—Heavy breeding of *C. pipiens* larvæ and pupæ found in the sewage north of the New York & Greenkood Lake branch of the Erie Railroad freight spur.

September 16—Light breeding of *C. pipiens* larvæ found in the sewage north of the New York & Greenwood Lake branch of the Erie Railroad freight spur.

October 10—Light breeding of *C. pipiens* larvæ and pupæ found in the sewage north of the New York & Greenwood Lake branch of the Erie Railroad spur.

DISTRICT No. 13, SECTION G.—Area between the Boonton branch of the Delaware Lackawanna & Western Railroad and the main line of the New York, Lake Erie & Western Railroad, extending from the Thirty-Second Street Line of the Pennsylvania Railroad northward to County Road.

DISTRICT No. 13, SECTION H.—Area between the Thirty-second Street Line of the Pennsylvania Railroad and Snake Hill, southward from the Boonton branch of the Delaware, Lackawanna & Western Railroad Station.

July 15—Light breeding of *A. cantator* and *A. sollicitans* larvæ found in blind ditches.

DISTRICT No. 13, SECTION I.—Area between the Thirty-second Street Line of the Pennsylvania Railroad and the Hackensack River extending southward from the New York & Greenwood Lake branch of the Erie Railroad.

May 15—Heavy breeding of *A. cantator* and *A. sollicitans* larvæ in about 100 holes.

July 2—Light breeding of *A. cantator* and *A. sollicitans* larvæ found in a dozen holes.

DISTRICT No. 13, SECTION J.—Area between the Thirty-second Street Line of the Pennsylvania Railroad and Snake Hill, extending northward from the New York & Greenwood Lake branch of the Erie Railroad.

May 29—Light to heavy breeding of *C. pipiens* larvæ and pupæ found in two ditches just north of the New York & Greenwood Lake branch of the Erie Railroad.

July 2—Scattered breeding of *A. cantator* larvæ found in a pool 75 feet north of the New York & Greenwood Lake branch of the Erie Railroad.

July 15—Light breeding of *C. pipiens* larvæ found in a blind ditch.

July 27—Light breeding of *A. cantator* and *C. pipiens* larvæ found in two blind ditches.

August 20—Light breeding of *C. pipiens* larvæ found in a pool and one blind ditch.

DISTRICT No. 13, SECTION K.—Area between the Boonton branch of the Delaware, Lackawanna & Western Railroad and the main line of the New York, Lake Erie & Western Railroad, extending from Pen Horn Creek northward to the Thirty-second Street Line of the Pennsylvania Railroad.

June 8—Scattered breeding of *A. sollicitans* larvæ found in six holes on the south side of the Thirty-Second Street line of the Pennsylvania Railroad.

August 8—Scattered breeding of *A. sollicitans* larvæ found in one pool on the west side of the old Erie Railroad spur north of Pen Horn Creek.

August 20—Scattered breeding of *A. sollicitans* larvæ found in pools at the foot of the Thirty-Second Street Line of the Pennsylvania Railroad embankment. Light breeding of *C. pipiens* larvæ found in pools at the anchor post of the Pennsylvania Railroad.

DISTRICT No. 14, SECTION A.—Area between the Boonton branch of the Delaware, Lackawanna & Western Railroad and the Jersey City Water pipe line extending from the County Road northward to the Hackensack River.

DISTRICT No. 14, SECTION B.—Area between the Hackensack River and the Boonton branch of the Delaware, Lackawanna & Western Railroad extending from the County Road northward to the Boonton branch of the Delaware, Lackawanna & Western Railroad bridge over the Hackensack River.

DISTRICT No. 14, SECTION C.—Area between the Jersey City water pipe line and the main line of the New York, Lake Erie & Western Railroad extending from the old Iron Works Railroad spur northward to the Hackensack River.

May [illegible]—Heavy breeding of *A. cantator* larvæ found which covered about

DISTRICT No. 14, SECTION D.—Area between the Jersey City water pipe line and the main line of the New York, Lake Erie & Western Railroad, extending from the County Road northward to the old Iron Works Railroad spur.

May 29—Heavy breeding of *A. cantator* larvæ and pupæ found for a distance of about 300 feet between Anderson's and Cæsar's Creek.

July 2—Scattered breeding of *A. cantator* larvæ found in pools and an overgrown ditch just east of the Jersey City water pipe line.

July 15—Heavy breeding of *A. cantator* and *A. sollicitans* larvæ and pupæ found over the whole meadow between Anderson's and Cæsar's Creek and County Road.

July 27—Scattered breeding of *A. cantator* larvæ found in depressions between Anderson's and Cæsar's Creeks.

DISTRICT No. 15, SECTION A.—Area between the Hackensack River and the upland in Jersey City, extending from Newark Avenue southward to the Newark and Jersey City Plank Road.

May 26—Light breeding of *C. pipiens* larvæ found along the edge of the Logan Avenue dumping ground.

June 9—Light breeding of *A. sollicitans* larvæ found on all parts of the meadow.

June 22—Heavy breeding of *C. pipiens* larvæ found at Logan Avenue dumping ground and along the west side of the Cemetery just south of the Sip Avenue sewer.

July 3—Light breeding of *A. cantator* and *A. sollicitans* larvæ over the whole area.

July 16—Light breeding of *A. cantator* and *A. sollicitans* larvæ found in six sign post holes east of Mengle's box plant, ten small pools 300 feet south of the old shooting range, and two ditches between the Sip Avenue sewer and the race track. Scattered breeding of *C. pipiens* larvæ found along the edge of the Logan Avenue dumping ground.

July 28—Light and heavy breeding of *A. sollicitans* larvæ found in very many pools over the whole section. Heavy breeding of *C. pipiens* larvæ and pupæ found along the edge of Logan Avenue dumping ground.

August 10—Light breeding of *A. sollicitans* larvæ found in three sign post holes east of Mengel's box plant. Light and heavy breeding of *C. pipiens* larvæ and pupæ found at Logan Avenue dumping ground. Light breeding of *A. cantator* larvæ found in two pools south of the race track.

August 21—Scattered breeding of *C. pipiens* larvæ found in six pools at the Mengel's box plant. Scattered *A. sollicitans* larvæ found at the sign boards east of Mengel's box plant. Light and heavy breeding of *C. pipiens* larvæ and pupæ found in the cattails and at the edge of the Logan Avenue dumping ground. Scattered breeding of *C. salinarius* larvæ found in six pools at Dallis Avenue south of the Jersey City branch of the Pennsylvania Railroad.

September 3—Scattered breeding of *C. pipiens* larvæ found along the edge of the Logan Avenue dumping ground.

September 22—Scattered breeding of *A. sollicitans* larvæ found in about 50 per cent. of the pools along the Hackensack River.

District No. 15, Section B.—Area between the Hackensack River and the Morris Canal, extending from the Newark and Jersey City Plank Road southward to Danforth Avenue.

May 26—Light breeding of *A. cantator* larvæ and pupæ and *C. pipiens* larvæ was found in a good many holes along the Arlington Water Company pipe line west of the Morris Canal.

June 9—Light breeding of *A. sollicitans* larvæ found in two pools south of the Newark and Jersey City Plank Road, in a good many pools south of the Newark and New York branch of the Central Railroad of New Jersey in three pools south of the Mutual Chemical Company plant.

June 22—Scattered breeding of *A. cantator* and *C. pipiens* and *C. salinarius* larvæ was found in six holes along the Arlington Water Company pipe line.

July 3—Scattered and light breeding of *A. cantator* and *A. sollicitans* larvæ in very many pools over this area. Scattered breeding of *C. pipiens* eggboats and larvæ found in three holes along the Arlington Water Company pipe line.

July 16—Light breeding of *A. cantator* and *A. sollicitans* larvæ found in a few holes and pools south of the Newark and New York branch of the Central Railroad of New Jersey. Scattered and heavy breeding of *A. cantator* and *C. pipiens* larvæ and pupæ found in 75 per cent. of the holes along the Arlington Water Company pipe line.

July 28—Scattered breeding of *A. sollicitans* larvæ found in a few holes.

August 10—Scattered breeding of *C. pipiens* larvæ found in six holes along the Arlington Water Company pipe line.

August 21—Scattered breeding of *A. sollicitans* larvæ found in three pools along the Arlington Water Company pipe line, at the Hackensack River.

September 22—Scattered breeding of *A. sollicitans* larvæ found in 12 pools, south of the Newark and New York branch of the Central Railroad of New Jersey.

District No. 16.—Area between the Paterson Plank Road and Moonachie Creek, extending from the Hackensack River westward to the Moonachie and Little Ferry Road.

May 19—Scattered *A. cantator* larvæ found over about one-half an acre, and in overgrown ditch about 1,000 feet west of the Hackensack River north side of Paterson Plank Road.

June 17—Heavy breeding of *A. cantator* larvæ was found covering about two acres and also in a ditch which runs along the north side of the Paterson Plank Road for a distance of about 1,200 feet. Scattered breeding of *A. cantator* larvæ was also found.

July 10—Light breeding of *A. cantator* and *A. sylvestris* larvæ found in an overgrown ditch along the Paterson Plank Road for about 1,200 feet. Light breeding of *A. cantator* and *A. sylvestris* larvæ found about 900 feet west of the Hackensack River which covered about one and one-half acres.

July 23—Scattered breeding of *A. cantator* larvæ found in one pool along the north side of the Paterson Plank Road 900 feet west of the Hackensack

River. Heavy breeding of *C. pipiens* larvæ found in manure pool 10 and 12 feet on the east side of the Little Ferry Road, one-fourth mile north of the Paterson Plank Road.

August 5—Scattered breeding of *A. cantator* and *A. sylvestris* larvæ found in depressions and overgrown ditch 900 feet west of the Hackensack River.

District No. 17, Section A.—Area of upland along Woodridge Road and Moonachie and Little Ferry Road, extending from the Paterson Plank Road north and westward to Berry's Creek.

August 17—Heavy breeding of *C. pipiens* larvæ and pupæ found in the gutter on the west side of the Moonachie and Little Ferry Road, about one-fourth mile north of the Paterson Plank Road.

District No. 17, Section B.—Area of woodland located between Berry's Creek and the upland east of Berry's Creek, south of Woodridge Road.

District No. 17, Section C.—Area between Berry's Creek, the woodland and the upland west of the Moonachie and Little Ferry Road, extending from the Paterson Road northward to Woodridge Road.

May 19—Scattered *A. cantator* and *A. sylvestris* larvæ found 1,200 feet west of Little Ferry Road.

June 27—Scattered breeding of *A. cantator* and *A. sylvestris* larvæ found over an area of about one and one-half acres. Scattered breeding of *A. sylvestris* larvæ found in gutter between retaining wall and Grand Street. Heavy breeding of *C. pipiens* larvæ found in gutter on east side of Grand Street.

July 11—Scattered breeding of *A. cantator* and *A. sylvestris* larvæ found in depressions along the Paterson Plank Road.

District No. 18.—Area between Berry's Creek and the New Jersey and New York branch of the Erie Railroad, extending from the Paterson Plank Road northward to Woodridge Road.

May 19—Light breeding of *A. cantator* and *A. sylvestris* larvæ and pupæ was found in cattails north of Broad Street, Carlstadt; also light breeding of *A. sylvestris* just east of brick works; also 11 acres of light breeding of *A. cantator* and *A. sylvestris* about 500 feet east of the Erie Railroad.

May 28—Heavy breeding of *C. pipiens* larvæ was found in two wells at the retaining wall south of Woodridge Road; also in two large lot pools south of Woodridge Road and east of the New Jersey and New York branch of the Erie Railroad.

June 16—Scattered breeding of *A. cantator* and *A. sylvestris* larvæ found north of Broad Street in Carlstadt; covered about one acre.

June 27—Scattered breeding of *C. pipiens* eggboats and larvæ found in pool 10x75 feet on the southwest corner of Bergen Street and Woodridge Road.

June 29—Scattered breeding of *C. pipiens* larvæ found in a ditch about 200 feet east of the Carlstadt Station, north side of Paterson Plank Road

July 11—Scattered breeding of *A. cantator* and *A. sylvestris* larvæ found south of the old brick plant in depressions.

District No. 19, Section A.—Area between Merhoff Road and the Little Ferry Road, extending from the Hackensack River westward to Merhoff Road.

District No. 19, Section B.—Area between Merhoff Road and Eckel's Creek, extending from the Hackensack River westward to the Little Ferry Road.

June 17—Heavy breeding of *A. cantator* and *A. sylvestris* larvæ and pupæ found which covered an area of about two and one-half acres.

June 20—Light breeding of *A. cantator* and *A. sylvestris* larvæ and pupæ found.

July 10—Scattered breeding of *A. cantator* and *A. sylvestris* larvæ and pupæ found over an area of five acres.

August 5—Scattered breeding of *A. cantator* larvæ found in a few depressions.

District No. 19, Section C.—Area between Moonachie Creek and Eckel's Creek, extending from the Hackensack River westward to the upland east of the Moonachie and Little Ferry Road.

July 10—Scattered breeding of *A. cantator* larvæ found south of Eckel's Creek in small depressions.

District No. 20.—Area between the Hackensack River and the Bergen Pike, extending from Lodi Road in Little Ferry northward to New York, Susquehanna & Western Railroad, in Hackensack.

District No. 21, Section A.—Area between Cromakill Creek and Mill Creek, extending from the Paterson Plank Road northward to the Hackensack River.

June 30—Scattered breeding of *C. pipiens* larvæ found in two pools 2x3 feet in diameter about 800 feet north of the Paterson Plank Road.

July 13—Scattered breeding of *C. pipiens* larvæ found in sewage ditch on the east side of Mill Creek. Light breeding of *C. pipiens* larvæ and pupæ found over about one-fourth acre opposite the First National Bank of Secaucus. Light breeding of *C. pipiens* larvæ found in a ditch opposite Gardner's blacksmith shop.

July 24—Light breeding of *C. pipiens* larvæ found in a ditch 50 feet long on the east side of Mill Creek.

August 18—Light breeding of *C. pipiens* larvæ and pupæ found in a sewer ditch east of the Kiesewether building on the north side of the Paterson Plank Road.

District No. 21, Section B.—Area between the Hackensack River and Mill Creek, extending from the Paterson Plank Road northward to the mouth of Mill Creek.

June 5—Light breeding of *A. cantator* pupæ found in farmers' ditch near where Mill Creek empties into the Hackensack River.

July 13—Light breeding of *A. cantator* found in the farmers' ditches near the mouth of Mill Creek.

July 24—Scattered breeding of *A. cantator* larvæ found in a farmer's ditch near the mouth of Mill Creek.

July 6—Light breeding of *C. pipiens* and *A. sylvestris* larvæ found the [illegible] ditches along the Hackensack River north side of the Paterson Road

August 18—Light breeding of *C. pipiens* larvæ found in four farmers' ditches near the mouth of Mill Creek.

DISTRICT No. 22.—Area between Cromakill Creek, Hackensack River, and the Erie Railroad and New York, Susuehanna & Western Railroad, extending from the Paterson Plank Road northward to Bellman's Creek.

May 21—Scattered breeding of *A. cantator* larvæ found north of Babbitt plant and scattered breeding of *A. cantator* larvæ and pupæ was found south of the Edgewater branch of the Erie Railroad.

June 5—Heavy breeding of *C. pipiens* larvæ and pupæ found in the ditch north of New Durham Station and 14 barrels with heavy *C. pipiens* breeding of larvæ and pupæ.

June 18—Scattered breeding of *A. sylvestris* larvæ found in a pool 300 feet north of the New Durham Station east of the New York, Susquehanna & Western Railroad.

June 30—Scattered breeding of *A. cantator* larvæ found in six sign post holes south of the Babbitt soap plant. Scattered breeding of *A. sylvestris* and *C. pipiens* larvæ in a pool 300 feet north of the New Durham Station east of the New York, Susquehanna & Western Railroad.

July 13—Scattered and heavy breeding of *A. cantator* and *A. sylvestris* larvæ found in holes and depressions on the north side of the New York, Ontario & Western Railroad. Scattered breeding of *A. cantator* larvæ found in depressions just north of the Babbitt Soap Company's office. Scattered and light breeding of *C. pipiens* and *A. sylvestris* larvæ found in the pools and cattails on the east side of the New York, Susquehanna & Western Railroad between New Durham and Homestead.

July 24—Light breeding of *C. pipiens* larvæ found in swamp just north of the Babbitt Station on the New York, Susquehanna & Western Railroad. Light breeding of *C. pipiens* larvæ found in cattails south of the Granton Quarries east of the New York, Ontario & Western Railroad. Scattered breeding of *C. pipiens* larvæ found in cattails just south of New Durham Station east of the New York, Susquehanna & Western Railroad.

August 6—Scattered breeding of *A. cantator* larvæ found in five sign post holes south of the Babbitt soap plant. Scattered breeding of *C. pipiens* larvæ found in the cattails south of the Granton Quarries east of the New York, Ontario & Western Railroad. Light breeding of *C. pipiens* larvæ found in two pools 300 feet north of the New Durham Station east of the New York, Susquehanna & Western Railroad.

DISTRICT No. 23, SECTION A.—Area between the Hackensack River and the New York, Susquehanna & Western Railroad, extending from Bellman's Creek northward to the first natural creek.

May 21—Light to heavy breeding of *A. cantator* larvæ and about 80 per cent. pupæ found over an area of about one and one-half acres about 1,500 feet east of Hackensack River; also scattered breeding of *A. cantator* larvæ which covers about two acres about 500 feet south of New York, Susquehanna & Western Railroad and Edgewater freight line crossing.

July 13—Scattered and heavy breeding of *A. cantator* and *A. sylvestris* larvæ found in holes and depressions over about one acre about 700 feet south of where the Edgewater branch of the Erie Railroad runs over the New York, Susquehanna & Western Railroad.

August 6—Scattered breeding of *A. cantator* larvæ found in small depressions which cover about two acres.

District No. 23, Section B.—Area between the Hackensack River and the New York, Susquehanna & Western Railroad, extending from the first natural creek to the third natural creek north of Bellman's Creek.

June 30—Scattered and light breeding *A. cantator* and *A. sylvestris* larvæ found for a distance of about 1,000 feet just west of the Edgewater branch of the Erie Railroad.

District No. 23, Section C.—Area between the New York, Ontario & Western Railroad and the north branch of Bellman's Creek, northward from the Edgewater branch of the Erie Railroad.

May 21—Light breeding of *A. cantator* and *A. sylvestris* larvæ and pupæ found in about 100 small holes just north of the Edgewater branch of the Erie Railroad.

District No. 23, Section D.—Area between the Hackensack River and the New York Susquehanna & Western Railroad, extending from the third natural creek north of Bellman's Creek to the north branch of Bellman's Creek.

District No. 23, Section E.—Area between the north branch of Bellman's Creek and the Northern Railroad of New Jersey, extending from Bellman's Creek northward to Overpeck Creek.

District No. 23, Section F.—Area between the Hackensack River and the New York, Susquehanna & Western Railroad, extending from the north branch of Bellman's Creek northward to Overpeck Creek.

District No. 24, Section A.—Area between the Overpeck Creek and the upland in Ridgefield Park and Teaneck, extending from the Bergen Pike northward to the Hudson River Trolley Road.

District No. 24, Section B.—Area between the Overpeck Creek and the Northern Railroad of New Jersey, extending from the Bergen Pike in Ridgefield northward to Nordhoff.

District No. 25.—Area along both sides of the Hackensack River, extending from the New York, Susquehanna & Western Railroad northward to Cherry Hill.

District No. 26, Section A.—Area between Berry's Creek and the Little Ferry Road, extending from Woodridge Road northward to the Lodi Road.

District No. 26, Section B.—Area between the New Jersey and New York branch of the Erie Railroad and Berry's Creek, extending from Woodridge Road northward.

DISTRICT No. 26, SECTION C.—Area between the New Jersey and New York branch of the Erie Railroad and the upland to the west, extending northward.

DISTRICT No. 26, SECTION D.—Area between the New Jersey and New York branch of the Erie Railroad and the upland to the east, extending from the Lodi Road northward to Hackensack.

DISTRICT No. 26, SECTION E.—Area between the marsh and Bergen Pike from the Lodi Road to Hackensack.

DISTRICT No. 27.—Area lying between the Pennsylvania Railroad and the Passaic River.

The extreme northern end of this salt marsh did not receive the same careful inspection as that which lay south of the Paterson Plank Road, and the total absence of breeding records should not be taken to mean that no mosquitoes bred there during the past summer.

AID EXTENDED TO BOARDS OF HEALTH.

Allendale.

On June 10th, 1914, at the request of the Board of Health of Allendale the Entomologist examined the mosquito breeding places in and about Allendale. The following report was prepared and submitted.

"In accordance with our understanding I examined on June 10th the mosquito breeding territory in and about the town of Allendale. Most of the mosquitoes troubling Allendale in all probability come from two general sources—the breeding places in back yards and on city lots, and the swampy areas located about town.

"There are many cess-pools, open privies, cisterns, lot pools, open sewer drains, rain barrels, old tin cans and other receptacles in and about the various properties composing the town. In these places the house mosquito, and to some extent the malarial mosquito, will breed prolifically.

"In the swamps, five of which I examined yesterday, and the various ditches and brooks more or less breeding of the house mosquito, the malarial mosquito and swamp mosquito will probably occur.

"The breeding places located in the already built up lots can be attended to only by a house-to-house inspection and treatment. Every property in the town would have to be examined at least once in ten days and all breeding places treated by draining, filling, burying, cleaning, stocking with fish, screening, or regularly covering every ten days with a film of oil.

"The marsh breeding places, for the most part, would be exceedingly difficult to treat with oil and can best be eliminated by drainage. The present drainage system is obviously inadequate to carry the water away, and I would suggest that before any considerable sum of money is expended on the old drains a surveyor should be employed and directed to prepare a statement of the methods and the cost of adequate drainage, and that the authorities in the Borough adopt a definite drainage scheme

toward the accomplishment of which all efforts should be directed. Breeding in the brooks and ditches can be prevented by cleaning them in such a fashion that the side walls shall be free from grass and the bottom shall have an uninterrupted flow of water.

"I am inclosing a copy of Circular No. 13 on the house mosquito, a copy of the law under which your body would operate against these mosquito breeding places and a copy of an outline for an anti-mosquito campaign."

Dover.

On June 17, 1914, in response to a request from the Board of Health of Dover, the writer examined the "Mansion House" in that place for the source of a swarm of *C. pipiens* that had heen infesting the hotel for some time. It was soon discovered tbat this was the only house in Dover seriously troubled. A careful examination revealed a large pool of water under the freight elevator and a great overflow cess-pool in the cellar. No breeding was found in the elevator pool, for a heavy coating of oil had been administered some time before. The breeding conditions in the cess-pool could not be examined, for it was covered with heavy cement. The concentration of mosquitoes in these parts of the basement clearly indicated these places as the source. That this overflow pool had much water in it and that tbe hreeding was heavy was indicated hy Mr. Horgan's (the proprietor) statement that a short time previously it had been overflowing and that a mass of black wrigglers came out through one of the cracks.

Mr. Horgan was advised to fumigate his rooms with "culicide" or with hydrocyanic acid gas and to keep the elevator pool, the cess-pool in the cellar and all surrounding cess-pools and privies oiled. He was further advised that Mr. John G. Taylor, the local health officer, was the man to take charge of the operation for bim.

In course of these examinations an accident happened which threw light on the danger of using matches to make examinations of oil-treated receptacles. Mr. Horgan, desiring to show the writer a cess-pool outside the building, pulled away the stone cover and started to insert a lighted match. Instantly an explosion occurred and a flash of flame came from the vent, enveloping Mr. Horgan's head and badly singeing bair and skin.

Nor.

Fair Haven.

Ridge... beginning of this work lies in the year 1913. On request of the
Distric of Health of Fair Haven an investigation of certain ponds and
ing from n the borough was undertaken. The inspection began on Septem-
Cherry Hill 1913, and ended on the 19th. Mr. Henry H. Brehme, who made
ıation submitted the following report.

District N'as an investigation made of the various ponds and brooks in
Ferry Road, e.Fair Haven, with tbe assistance of Dr. G. V. V. Warner to
hat species of mosquitoes were breeding in them, and th
District No. e investigation was that *Anopheles* larvæ or the malarial
branch of the cies were either found actually breeding or were likely to be
Road northwa so in the following places:

"Section No. 1 is a pond which is located on the south side of Fair Haven Road east of Lake Avenue. This place is nothing more than a dirty hole, and *Anopheles* larvæ were found breeding along the edges of this pond. The best remedy here will be to connect the small spring-like stream which comes from the southwestern section of this pond, with a tile pipe and run the pipe to the northeastern end of the pond to drain it. Then the place should be filled, otherwise oiling will have to be done.

"Section No. 2 is a pond which is located between the Fair Haven Road and the Navesink River on the Hess property. This pond, which is used for cutting ice only, has very dirty edges, there being long grass and lilies growing along the edges, which make it an ideal *Anopheles* breeding place. *Anopheles* larvæ were found along the edges of this pond in fair numbers. The best remedy will be to keep the edges free of grass, so it will be possible for the fish to get into all parts of the pond and keep the edges free of breeding. If this pond has no fish in it at the present time, it should be stocked with sunfish or goldfish to make it safe after the edges are cleaned.

"Section No. 3 is a small race-way which is located on the east side of Section No. 2 north of the ice house. There was a scattering breeding of *Anopheles* larvæ found going on along the grassy edges of this race-way, and the best remedy will be to fill this place.

"Section No. 4 is a pond which is located on the south side of Fair Haven Road opposite the ice pond. There was scattering breeding of *Anopheles* found going on along the grassy edge of this pond, and the best remedy here will be to keep the edges free of grass. If this pond is not stocked with fish, it should be stocked with sunfish or goldfish to make it safe.

"Section No. 5 is a brook which comes from south of Section No. 4, and which feeds the pond known as Section No. 4. There was scattered breeding of *Anopheles* larvæ found going on along the edges of this brook, which are not very clean. The best remedy here will be to give this brook a thorough cleaning and keep the edges free of grass. If any pools are found to exist in a dry season andbreeding is found going on in them, oiling will have to be done.

"Section No. 6 is a brook which comes from the north side of Ridge Road between Leonard Avenue and Harrison Avenue in the Borough of Fair Haven, and flows south across Ridge Road into Shrewsbury Township. This is a dirty brook, being overgrown with grass and brush and a good many pools form here. There was breeding of *Anopheles* larvæ found going on along the edges of this brook in the Fair Haven and also in the Shrewsbury Township territories. The best remedy here will be to give this brook a thorough cleaning, and if there are any pools existing during a dry season and breeding is found going on in them, oiling will have to be done.

"Section No. 7 is a brook which comes from the Thomas N. McCarter estate and flows west across Pearl Street, then north across Fair Haven Road and empties into the Navesink River. There were scattered *Anopheles* larvæ found breeding along the edges of this brook, and the best remedy will be to give this brook a good cleaning and keep the edges

free of grass. If any pools exist in a dry season and any breeding is found going on in them, oiling will have to be done.

"Section No. 8 is a swamp which is located along Section No. 7, between the Fair Haven Road and the Navesink River. This section, which also has cattails growing in it is undoubtedly wet a good part of the season. Found egg boats and larvæ of *C. pipiens*, *A. sylvestris* larvœ, *Anopheles* larvæ and one *Anopheles* pupa. The best remedy here will be to cut lateral ditches from this swamp into Section No. 7 and drain it. Otherwise oiling will have to be done.

"Section No. 9 is a swampy place lying along Section No. 7 on the south side of Fair Haven Road. Although there was no breeding found going on here at the present time, it will undoubtedly breed *C. pipiens* and *Anopheles* in a wet season. The best remedy will be to cut lateral ditches about every 100 feet apart into Section No. 7 and drain it, otherwise oiling will have to be done if any breeding is found going on.

"Section No. 10 is a brook which comes from the Hagan estate on the east side of the Rumson Improvement Company's property near the Water Works and flows northwest and north across Fair Haven Road and empties into the Navesink River. This brook will undoubtedly breed *C. pipiens* and *Anopheles*. No breeding was found going on here at the present time, which is due to the fact that the heavy rainfall of the last two days washed out the brook. The best remedy will be to give this brook a good cleaning and keep the edges free from grass. If any pools exist in a dry season in which breeding is found, oiling will have to be done.

Section No. 11 is a swampy place lying along the east side of Section No. 10, on the south side of Fair Haven Road. *C. pipiens* larvæ and scattering Anopheles larvæ were found breeding here. The best remedy will be to cut lateral ditches about 100 feet apart into Section No. 10 and drain this section. Otherwise oiling will have to be done.

"Section No. 12 is a pond which is located on the Thomas N. McCarter estate on the east side of Pearl Street. This pond is safe and has clean edges with the exception of a small shallow section lying along the eastern shore, where there is grass growing along its edges. There were a few scattered *Anopheles* larvæ found breeding here. The best remedy will be to clean the eastern end of this pond of the grass, so the fish with which it is stocked can keep the edges free of breeding.

"Section No. 13 is a brook which comes from Section No. 12 on the McCarter estate and feeds the brook in Section No. 7. This brook is almost completely overgrown with grass. There were scattering *Anopheles* larvæ found breeding here, and the best remedy will be to give this brook a thorough cleaning. If any pools exist during a dry season in which breeding is found going on, oiling will have to be done.

"There are catch basins on the McCarter estate which will undoubtedly breed a good many *C. pipiens* or house mosquitoes. As I am not prepared to say at this time whether these catch basins are oiled during the mosquito breeding season, I would like to recommend that they be oiled about every ten days during June, July and August and every fifteen days from the 15th of May, and during the month of September.

"As Fair Haven has no sewer system, and undoubtedly has a great many cess-pools, which will breed a good many *C. pipiens* or house mosquitoes, I would like to recommend that all cess-pools be sealed with cement around the edges, and that if there be any vent or hole on the surface or stone cover, it shall be screened with fine mesh wire or sealed with cement. Otherwise oiling will have to be done every ten days during June, July and August.

"From the investigation made of the various breeding places in the Borough of Fair Haven, Monmouth County, it will be seen that the problem is a local one, and one over which the Board of Health of Fair Haven has jurisdiction. This board has power to compel property owners under the 'Duffield Amendment' to abate the nuisance found existing on their property."

On July 27th, 1914, in response to a further request Mr. Charles S. Beckwith was sent to examine the Loew and Ingraham ponds (Sections 1 and 4 of preceding report) for mosquito breeding. Later the Entomologist himself examined the ponds and personally presented to the board a report of the findings. The following letter, closing the incident came to hand about the middle of September:

"Dear Sir:—

"With reference to the Loew and Ingraham Ponds which were inspected by you on August 12th, the Board is pleased to advise that it has had a meeting with the owner and it now appears that we are in a fair way to have the entire section improved in accordance with our recommendations.

"Your hearty cooperation in the matter is appreciated.

Yours very truly,
(Signed) D. O. Wolcott,
Secretary."

Franklin Furnace.

On June 26th, 1914, in response to a request from the Board of Health of Franklin Furnace, the writer delivered an illustrated lecture on mosquitoes and their control. The meeting was held by the local board and Dr. E. A. Ayres and Mr. David C. Bowen, of the State Board of Health, were the other speakers present. The principal subject of interest was the malarial mosquito (*Anopheles quadrimaculatus* Say), for the valley in which this village is located is the scene of the worst malarial fever outbreaks in the State. At the time the writer was there, the malarial species was breeding abundantly. The State and local boards of health undertook some practical work in controlling these species as a means of reducing the prevalent malaria.

Haworth.

On May 3rd, in response to a request from the Board of Health transmitted by Mr. H. B. Vannote, President of the Bergen County Mosquito Extermination Commission, the Entomologist met the members of this board and examined the territory in and about Haworth for mosquito breeding. The following report of his findings was submitted:

"The first problem that confronts the people of Haworth is the destruction of a rather large brood of woodland mosquitoes now present in the wriggler form in the woodland pools throughout the Borough. These species do not fly far, and it is accordingly to be expected that those houses situated in the woodlands nearest the breeding places will be the most frequently visited. In every piece of woodland that I examined, including that which lies northwest of the Country Club, that which extends almost continuously eastward to and across the railway, that which is found along the eastern border of the Borough and that along the southern border, pools of water containing mosquito wrigglers were found. These wrigglers range from one-half to full grown. Providing the pools do not dry up before the transformations can take place and providing the weather stays warm, a brood of mosquitoes will be on the wing in ten days or less. If the weather at that time should be cold they will give little or no trouble. If, on the other hand, the weather be warm and people occupy their porches, considerable complaint may arise.

"The next mosquito problem will he the control of the swamp species. I found only a few wrigglers of this species during the examinations. Later in the season, however, it may be expected to breed in the more open woodland pools and in the open swampy areas. The control of this species is largely a matter of drainage supplemented by the judicious use of oil as the occasion demands.

"The next mosquito problem will be the control of the house species. Without doubt this is the most serious and difficult phase of the mosquito problem in Haworth. Beginning late in May this species, which is now hibernating in cellars and other protected places, will emerge and hegin breeding. From the time it gets a good start it will, in any water it can find, produce a brood every ten to fifteen days throughout the season. It will penetrate the sleeping rooms hy working through the screens. This species can be controlled only hy keeping everlastingly at it. Beginning June 1st a man experienced in such matters should be employed to examine all possible mosquito places in the Borough and to treat, or cause them to be treated, in such a way as to destroy the breeding every ten to twelve days throughout the season to the latter part of September.

"Beginning in July the malarial species will be found breeding in grassy streams and pools. The drainage which is necessary to get rid of the swamp mosquitoes, and the careful examination and treatment which is recommended for the house mosquito will take care of this species incidentally.

"The mosquito problem at Haworth could be met hy the following operations: (1) oiling the pools which will shortly give up a brood of woodland mosquitoes; (2) instituting a comprehensive system of economical and efficient drainage of pools and swampy places; (3) employing an inspector who understands such work to examine and treat, or cause to be treated, the mosquito breeding places within the limits of the borough once each ten or twelve days.

"To do this it will be necessary for the borough itself either through its governing body, or through a private organization to raise funds, and I would suggest that in this matter the borough request the co-operation of the Bergen County Mosquito Extermination Commission.

"I am unable to give you exact figures on the cost of such a campaign until I have had a chance to determine fairly accurately the drainage which will be necessary."

Long Branch.

At the request of the Long Branch Board of Health, on May 6th, 1914, the Entomologist examined the mosquito breeding conditions in and adjacent to that city. Some bad spots for *C. pipiens* were discovered, besides the usual city and town places that breed this species. The Board of Health was informed that the problem of controlling the local breeding species was not difficult, but that the good work on that phase of the problem might largely be annulled by flights from adjacent salt marshes. At the same time, however, the point was made that the worst breeders of the adjacent marshes were drained and that unless unusually favorable mosquito breeding conditions should prevail, there would be no effective flights from the salt marshes. On May 12th, 1914, at the request of the Board of Health, the Entomologist gave an illustrated lecture to the high school on mosquitoes and methods used in their control.

Trenton.

On request the writer made a trip to Trenton for the purpose of examining some mosquito breeding territory in that city. Dr. A. S. Fell met the Entomologist and pointed out the suspected spots. The indicated places were carefully examined and the following report submitted:

"On Saturday, April 18th, 1914, I made an investigation of low territory which extends between the Belvidere Division of the Pennsylvania Railroad and West State Street from Parkline Avenue to the asylum bridge. That portion between Westfield Avenue and the asylum bridge is penetrated with a meandering stream. The banks of this stream are greatly overgrown, and the malarial mosquito, *Anopheles quadrimaculatus* Say, will probably breed along the edges. That portion of the territory between Parkline Avenue and Westfield Avenue is not, at the present time, draining satisfactorily into anything and a considerable amount of stagnant water was found on it. I have no doubt that this stagnant water will breed the house mosquito, *Culex pipiens* Linn., and in all probability the malarial mosquito as well. The east end of this area seems much better drained than the west end, and I am informed that some time ago an effort was made to drain it.

"Under the 'Duffield Amendment' to the general health laws, approved March 28th, 1904, it becomes the duty of the Board of Health to cause the abatement of all water in which mosquito larvæ breed. While I have not actually seen breeding in this water, I have no doubt that at the proper season it will be found. The nuisance from the mosquito standpoint could easily be abated by the cutting of drainage ditches in such a

fashion as to connect this stagnant water with the meandering creek before mentioned, or with storm sewers should any be in the neighborhood and lie low enough to render such an operation practicable. Permanent abatement can be secured, of course, through filling and I would suggest that if practicable the city's ash garbage be diverted to this point and the low ground filled. Doubtless some arrangement with the owner of the land could be affected whereby he would pay the additional expense incident to carting the garbage that distance."

COUNTY MOSQUITO EXTERMINATION WORK.

The county mosquito extermination commission has been long enough at work to accomplish results of a character that merit careful consideration and study. In Essex County this organization has been organized and working three years spending $35,317.23, $65,313.99 and $62,997.75 the first, second and third years respectively. In Union County this organization has been at work three seasons, using $15,792.54, $31,107.05 and $23,746.35. In Hudson County two seasons of work have been completed, using $25,917.06 in 1913, $31,063.36 in 1914. In Atlantic County two seasons of work have been completed involving the expenditure of $16,666.75 in 1913 and $24,702.01 in 1914. In Passaic County there have been two years of demonstration and educational work, costing $3,061.60 in 1913 and $9,427.78 in 1914. In Camden County there has been one year (1913) of very limited educational work, costing $500.00 and one year (1914) of demonstrational and educational work, costing $2,929.44. In Cape May County there was one year (1913) of educational and survey work costing $500.00. In Bergen County there has been one year (1914) of educational and demonstrational work, costing $800.00. Middlesex County has just completed its first season of demonstrational and educational work at a cost of $5,427.46.

What has been done with this large amount of money* and the results that have been accomplished are set forth in the annual report of these counties which either have already been, or soon will be, published and may be obtained by any one interested.

The Entomologist believes that the time has arrived when the first comprehensive analysis of the work of the county mosquito extermination commission can be made, but finds that the data in his possession are not sufficient to permit satisfactory work of this sort. Such consideration of county mosquito extermination work will have to await the securing of the necessary detailed data. A movement looking toward the collection of this necessary body of facts has already been set on foot.

Enough data are, however, already in the writer's files to show that the cost of mosquito extermination depends upon the density of the population, the extent and character of the territory to be protected, and relation which this territory bears to other breeding territory.

Other things being equal as the density of the population increases the per capita cost of mosquito extermination decreases. Just what the

* These figures represent the latest revision and are as accurate as the writer has been able to obtain.

limits of this principle are, data are not at hand to show, but it can be said that it seems to apply to all the practical work of mosquito control now going on in the State. The operation of this factor is pretty well shown by comparing the cost of mosquito extermination in Essex and Union Counties. Essex County has a population of 4356 per square mile and Union 1455. Essex expended per capita in the partial year of 1912, 6.4 cents, in the full years of 1913 and 1914, 11.8 cents and 11.4 cents respectively as compared with 10.6 cents, 20.8 cents and 15.9 cents per individual in Union in 1912, 1913 and 1914 respectively.

That increase in area of territory under protection when other factors remain unchanged means increase in cost of protection needs no proof. It is self-evident. Protection of a territory is more or less expensive as the prolific breeding area in it is large or small. A light sandy soil is conducive to low cost of protection for such soil does not retain pools of water on its surface long enough to breed mosquitoes. On the other hand, impervious clay soil usually means high cost of protection for the reason that pools of water are readily retained long enough to breed mosquitoes. The presence or absence of large, breeding, fresh or brackish water swamps means increased or decreased expenditure.

Whether the territory, which it is proposed to protect from mosquitoes, is within the flight of mosquitoes breeding in incalcuable numbers on a salt marsh or a large favorable fresh water swamp determines whether real protection is possible or not. The best efforts, which may control in a highly satisfactory manner all mosquitoes breeding within the territory to be protected, will count as nothing if swarms of the pest come in from points outside the area.

THE MOSQUITO PROBLEM IN ESSEX COUNTY.

The physical surface of Essex County begins at sea level as a 4,000-acre salt marsh and rises to the height of 600 or more feet. Until the northeastward ranging hills are reached the height of land rarely exceeds 200 feet. All this lower level of land is cut by meandering streams which afford the somewhat heavy soil pretty fair drainage.

The hilly sections are well forested and have many pools in which the woodland species of mosquitoes breed, giving to this county an important woodland-pool-mosquito problem. The streams that meander through both the hilly and the lowland sections of the county in some cases do not completely drain all parts of their valleys, thereby creating a considerable number of swamps from which the swamp species issue in sufficient numbers to constitute a problem.

The streams and ponds of this county exhibit a heavy growth of grass along their edges, and some of the latter when the dry season has lowered the level are sufficiently shallow to show a growth of coarse grass over much of their bottoms. In the water behind the screen of the grass the malarial mosquitoes breed and issue in sufficient numbers to demand attention.

The great bulk of the half million persons living within the limits of the county is gathered on the lowland in and adjacent to the city of Newark.

The changes incident to the transformation of country into city have dammed many of these meandering streams transforming them into virulent breeding places for the house mosquito. These changes have polluted a large part of the streams, ponds and pools and rendered them bad breeders for the same species. The presence of so many people has meant necessarily the multiplication of the ordinary house and yard breeding places. All of these factors have contributed to the breeding throughout the season of vast numbers of house mosquitoes, the suppression of which is a very large work.

The 4,000-acre salt marsh has been crossed and criss-crossed by railways and roadways, and all drains except the great creeks, utterly destroyed. The marsh has thus been broken up into parts of various sizes, all furnished with insufficient outlets. To make a bad matter worse the city of Newark dumps in one way or another much of its raw sewage in various ones of these divisions. The blocking up of the drainage insured the abundant breeding of the salt marsh mosquitoes, and polluting the water with sewage made certain the breeding of enormous numbers of house mosquitoes. It is from these separate portions of the original salt marsh that most of Essex's intraterritorial mosquitoes come. From it in spite of drainage and the free use of oil came *A. cantator* to form a part of the early May brood. From it came the *A. cantator* that formed a part of the mid-July issue. From the sewage charged parts came the *A. cantator* infestation of South Newark, Irvington, and Union Township of Union County. From the same cource came the house mosquito troubles in South Newark and a part of North Elizabeth.

Unfortunately Essex County is located within the reach of the marshes of the Hackensack Valley and from that source it received that portion of the early May brood found in eastern and northeastern portions of its territory. From the same source came the mid-July infestation of these parts and from it the supply was kept up until the dry weather of late summer.

Unfortunately Essex's northern border is close enough to the swampy places on the Great Piece Meadows to be visited on occasion by species bred there. Generally speaking, however, the trouble from this source is very limited.

The present methods of mosquito control worked with a little more care will render the woodland, swamp, malarial and house species negligible factors in human comfort. But the methods of controlling breeding on the salt marsh are insufficient.

The insufficiency of the present salt marsh drainage was absolutely demonstrated during July when despite utmost efforts (cleaning ditches, cutting new ones and oiling) a large brood of mosquitoes escaped. At this time wherever water stood mosquitoes bred.

Shortly after the issue of the mid-July brood the Entomologist published the following article in response to a request for information:

"I have been requested to state the source of the salt marsh mosquitoes now infesting Glen Ridge in Essex County. They, in common with the salt marsh mosquitoes now infesting to a greater or less extent, parts of

Hudson, Bergen, Passaic, Essex and Union Counties, escaped from the salt marshes of the Hackensack Valley and Newark Bay between the 10th and 20th of this month. It should be understood that these dates are approximate, some emerging before the 10th and some after the 20th.

"About June 21st the tides began to run high and continued to do so for almost twenty days, lacking very little of reaching the level of the spring tides. During this period the weather was cloudy and considerable rain fell, preventing rapid evaporation and increasing the volume of water. The ditching systems could not carry off the water fast enough, and the depressions between the ditches which would, under normal conditions, have dried out promptly, remained filled with water and breeding. On many of the meadows continuous sheets of water, in some cases many acres in extent, were breeding.

"The mosquito commissions were fully aware of this condition, but were practically helpless. They did the only thing which under the circumstances could be done—placed oil on the meadows to be used as soon as the water fell sufficiently to render spreading of it practicable.

"On the more open meadows of southern Union and of Middlesex Counties killifish consumed most of the wrigglers, and the oil spreading left comparatively few to emerge; but on the low lying, shut-in meadows of northern Union, Essex, Hudson, Bergen, especially of the last three counties, the utmost oiling proved insufficient.

"The woodland pool, swamp, house and malarial mosquito breeding on the upland is now under pretty good control and would, but for certain sewage-charged salt marshes, be so satisfactory that these species would be eliminated as a factor in human comfort and health.

"The phase of mosquito breeding which the mosquito commissions have been under extreme conditions of weather and tide able only partially to control, and which is responsible for the present outbreak, is on the salt marsh, particularly on the shut-in and low-lying parts of it. Shut-in marshes have been created almost entirely by man's activity. The making of streets, roadways, railroad grades, garbage fills, mud and sand fills and dykes is responsible. The shut-in meadow shrinks and becomes low-lying. To make matters worse raw sewage is poured into many of these marshes and so sweetens the brackish water that the house mosquito breeds in it in enormous numbers and migrates over the adjacent upland, in some cases to points distant two and one-half miles.

"The normal open high-lying meadows will be rendered free from that mosquito breeding which now occurs under extreme conditions by additional ditching and by enlarging the outlets. The shut-in and low-lying marshes are being fitted with sluice gates, by means of which the water passes out at low tide and is prevented from entering at high tide. In times of heavy rainfall and high tides during the breeding season power pumps will have to be used to aid the sluices. In this way all of these marshes that are not filled can and eventually will be rendered entirely free from mosquito production.

"When we remember that in round numbers Union County has 4,000, Essex County 4,000, Hudson County 10,000, and Bergen County 9,000 acres of salt marsh, it is easy to understand that the prevention of absolutely all breeding is a very large and difficult problem. Much has already been done. The drainage systems on all these marshes, except those of Bergen County (a few limited areas excepted), are such that under ordinary conditions of weather and tide few mosquitoes can get off. Work is constantly going on to render these meadows mosquito-proof, even under the most extreme conditions of weather and tide, but much yet remains to be done.

"Breeding places for mosquitoes are now far less in number than ever before in Union, Essex and Hudson Counties, and the time is not far distant when these salt marsh broods will come no more."

The mosquito commission became convinced that some more effective method of handling these marshes must be found. At the suggestion of the writer the president of the commission, Dr. Ralph H. Hunt, and the chief inspector, Mr. John W. Dobbins, examined an area in the Hackensack Valley under dike and sluice gate and found the surface in spite of the rainfall and cloudy weather (which had proven so disastrous on the Essex meadows) dry and free from breeding. This seemed to offer a solution for the problem. After having the diking and sluice-gating elsewhere in the State carefully studied by the consulting engineer, Mr. James Brooks of Glenn Ridge, the commission empowered the engineer to proceed with plans for diking and sluice-gating the worst sections of the Essex salt marshes.

There was, of course, no way in which Essex could by work within its own limits prevent salt marsh mosquitoes bred on the Hackensack from entering its territory. The commission did, however, furnish inspectors to cooperate with the writer for the purpose of determining where the breeding occurred and caused the concentrated breeding located by this inspection in the Bergen County section of the Hackensack marsh to be oiled in the hope of reducing the mosquitoes coming into Essex from that source.

THE MOSQUITO PROBLEM OF UNION COUNTY.

The physical surface of Union County begins, like that of Essex, at sea level with a salt marsh of about 4,000 acres (which, however, is divided into three distinct parts) and rises gently to the northwest to a height of about 600 feet. From the marsh to the northeastward running range of hills (the same range as that found in Essex) the height does not for the most part exceed 200 feet.

Streams meander through this area but do not drain it so efficienly as Essex. Swamps are larger in size and greater in number.

The swamp mosquito problem is correspondingly more difficult than in Essex.

The hilly portions of Union County are pretty well wooded and a considerable number of woodland pools are present. While the number of woodland pool mosquitoes issuing from them must be reckoned with, the problem is not so important as in Essex.

The grassy banks of streams and ponds afford breeding places for a considerable number of the malarial mosquitoes rendering them a factor to be reckoned with.

The 4,000-acre salt marsh is fortunately far less cut up than that of Essex and has very little sewage contamination. The problem of control is, therefore, much less difficult. The crossing of the marshes by the Central Railroad of New Jersey and by spur and sidings thereof has, however, materially interfered with the original drainage. Small creeks have

been filled and the areas they originally drained left without outlets. Drainage systems have been established in all the marshes. These with proper supplementing by additional ditching and killifish will probably be found ample to prevent the issuance of large numbers of mosquitoes even under such extreme conditions of tide and weather as obtained in June and July of this year.

In expressing this opinion the writer realizes that he is running counter to opinions of others who are as well informed as he. He holds this view because more open and better drained marshes under just as severe test have turned out a negligible number of mosquitoes because the killifish, which failed to penetrate these meadows in large numbers, were present everywhere and consumed the mosquito wrigglers.

At the same time the cost of diking and sluice-gating certain of the most difficult parts of these meadows is very small and the chance for keeping the water down excellent. In such instances the cost of thus protecting the meadow is probably less, or at any rate no greater than that involved in cutting the necessary additional ditches.

The experience of the present year has been sufficient to demonstrate that additional ditching is needed on the Union County salt marshes for under the extreme test of June and July many mosquitoes escaped.

To a certain minor extent Union County lies within reach of salt marsh mosquito flights from the Hackensack Valley and the Essex portion of the Newark Bay marsh. From the latter, its northeastern border was infested in mid-July by *A. cantator* and later by that species and *C. pipiens*.

THE MOSQUITO PROBLEM IN HUDSON COUNTY.

Hudson County covers only forty-three square miles,* much less than half the space covered by Essex and but little more than one-third the space covered by Union. It consists of two rather broad ridges extending from southwest to northeast with the broad salt marsh of the Hackensack River lying between them. The eastern ridge extends from the Kill Van Kull northeastward along New York Bay and the Hudson River to the northern boundary of the county. The western ridge extends from the Passaic River northeastward along its eastern bank to the northern boundary of the county. On the eastern ridge lie the towns of Bergen Point, Centerville, Bayonne, Saltersville, Greenville, etc., Jersey City, Hoboken, West Hoboken, Weehawken, etc. This ridge from the southwestern end to New Durham is almost solidly built up. Beginning at the southern end of the western ridge the towns of Harrison, Kearny and Arlington form a continuous city to the northern limit of the county.

On these two ridges are concentrated a half million of people.

Hudson County has no woodlands of any considerable size and consequently practically no woodland pool mosquito problem.

* Land surface.

Hudson County's upland consists of ridges that because of their strong slopes are so well drained that it has practically no fresh water swamps. The swamp mosquito problem in this county is small; some few *A. sylvestris* and *C. perturbans* breed in parts of the Hackensack Valley marsh.

The concentration of its population on these two well-drained ridges produces the smallest number of breeding places for the house mosquito possible with such a large population. If the only mosquitoes Hudson County has to fight were those bred on the ridges, mosquito control would be very inexpensive.

Unfortunately, the advantage which Hudson County gains by the concentration of her people on exceedingly well-drained land, is largely lost through this land lying adjacent to an enormous salt marsh. Approximately 10,000 acres of salt marsh lie within the Hackensack Valley and a small amount is found near Constable's Point.

This enormous marsh is only partly drained. Its original drainage has been almost completely ruined by railway and roadway grades and large fills. Wherever mosquito breeding has been found and the nature of the marsh rendered the cutting of 10x30 inch ditching likely to prove effective ditches have been put in with judgment and are giving excellent service. There are, however, many places where through railway grades and roadways or great sand and garbage fills the success of ditching demands the cutting of large outlets, or the installation of pumping plants, and in such places little effective drainage has been done. To make a bad matter worse, in this county as in Essex, certain of these shut-in marshes are made dumping grounds for raw sewage. In some instances the sewers empty right into the open marsh, while in others they drain into creeks that have become clogged and spill over the banks into the meadows. There yet remains much work to be done before this area can be free from mosquito breeding.

To a certain minor extent Hudson County is infested by mosquitoes that breed outside its confines. For instance, the writer has considerable reason to think that the southwestern end of the eastern ridge was during the latter part of the summer this year infested by *A. sollicitans* bred on the marshes of Union County just across Newark Bay.

Hudson County's great and practically only problems in mosquito control are the salt marsh forms bred within its limits and the house mosquitoes bred both on its uplands and its sewage-charged marshes. The control of the house mosquito bred on the upland is simple, but the control of *A. cantator* and *C. pipiens* breeding on the marshes is very difficult indeed.

THE MOSQUITO PROBLEM IN ATLANTIC COUNTY.

Physically, Atlantic County begins at sea level as a low strip of sand rising from the ocean. Behind this narrow strip lies a salt marsh which

stands but slightly above mean high tide. Back of this stretch gently rising to a height of a little more than 100 feet and nowhere really hilly the county stretches northwestward to its limits. Except where it has been cleared for agricultural or urban purposes the whole face of the county is covered with scrubby oak and pine.

Except in cedar swamps and occasional holes the water does not lie on the sandy and gravelly surface long enough for mosquitoes to breed. The woodland pool mosquito problem does not apparently exist.

The great cedar swamps for some reason, possibly low temperature or lack of food for the wrigglers, do not breed an appreciable number of mosquitoes. The swamp mosquito problem seems to be limited to a few *C. perturbans* and an occasional *A. sylvestris*.

Where the population is sufficiently concentrated as is the case in the cities and towns the improper disposal of human waste and other operations incidental to transforming country into urban property, create breeding places for the house mosquitoes. Excavations under houses, cisterns, cess-pools, open privies, garbage dumps, barrels, tubs, buckets and pools serve this purpose. The problem of controlling the house mosquito is, however, not difficult and has been very satisfactorily handled in the past two seasons.

It is, however, in the salt marsh and the control of the species it breeds that Atlantic County has its great problem. Of the 569 square miles approximately seventy-eight are salt marsh. These seventy-eight square miles divide the costal strip from the main land by a belt of marsh and water, ranging from two and one-half miles at the southern end to six at the northern end. This salt marsh extends along the northeastern border of the county for twelve or more miles and for a somewhat greater distance along the southeastern boundary. Although mosquitoes breed over a small proportion of this total area the breeding spots are scattered throughout and the problem of eliminating them is a large one. Already the breeding places on the costal marsh from Absecon to Somers Point have been eliminated, and recently those on Patcong Creek and the lower section of the Great Egg Harbor River have been destroyed.

Careful observations of the past two seasons made by Mr. Eaton and his inspectors have shown that the mosquitoes bred to the northward of a given point rarely visit that point. Acting on this information the northern end of the salt marsh adjacent to which few persons live has not been touched and the whole effort has been directed to draining the territory lying to the south and west of the principal centers of population—to eliminating the breeding places from which the mosquitoes that reach these centers come.

Unfortunately, the salt marshes of northeastern Cape May County are close enough to the main centers of population in Atlantic County to furnish a pest of mosquitoes under extreme breeding conditions such as obtained in June and July of this year. It is not, therefore, to be expected

that the result of the excellent drainage work done in Atlantic County will under extraordinarily favorable breeding conditions be as satisfactory as it should until the salt marshes of northeastern Cape May County are adequately drained and looked after.

THE MOSQUITO PROBLEM IN PASSAIC COUNTY.

Passaic County on the map has roughly the shape of an hour glass with the small end to the southeast. All south of Pompton Lakes forms the southern division and all north the northern portion. Considerably more than one-half the area lies in the northern section but approximately 200,000 out of the 215,902 inhabitants live in the southern part.

The surface from Paterson south while rolling is not rugged, but from Paterson north it assumes a rather rugged character.

The hilly portions are well wooded and have many pools. The woodland pool mosquitoes must form a serious problem in the rougher parts of the county. No thorough investigations of this point have been made.

Although a very considerable number of small swamps exist in the southern part of this territory and although the Great Piece Meadows are only a few miles away the mosquitoes taken during the summer in the City of Passaic and elsewhere in the county showed few specimens of the swamp species. It does not look as if the swamp mosquito problem can be a very important one. At the same time the writer feels that a different type of season might give a different result.

The population in the southern end of the county is rather concentrated and the usual breeding places for the house mosquito are abundant. In addition to this the cities of Paterson and Passaic have a very large number of factories in which numerous water holding receptacles are kept. The soil is by nature fairly well drained, but is sufficiently tight to hold water in depressions long enough for mosquitoes to breed.

The rather careful tests of the past season in the City of Passaic have shown that the house mosquito and all the other local breeding species can be satisfactorily controlled.

In view of this fact it is especially to be regretted that the past season's studies have shown with equal clearness that salt marsh mosquitoes *(A. cantator)* were present in the City of Passaic from late July to late August in sufficient numbers to render the occupation of unscreened porches in shrubbery-filled yards very uncomfortable. These salt marsh mosquitoes came from the Hackensack Valley. That Passaic County would in ordinary seasons be free from salt marsh mosquitoes with the exception of an early spring non-troublesome hrood is hardly to be doubted. Nevertheless, the fact remains that the good results of the most successful control of the local species are under unusually favorable breeding conditions on the Hackensack salt marshes likely to be overwhelmed by hroods of salt marsh migrants from that source until that marsh is drained and rendered free from mosquito breeding.

THE MOSQUITO PROBLEM OF CAMDEN COUNTY.

Physically Camden County begins at the Delaware River only a few feet above the sea and rises gently to the southeast, reaching in some places about 200 feet. The soil is light, beginning at the river as a loam and ending to the southeast in the sand typical of South Central Jersey. Many streams, some of which lead to the Delaware and others to the Atlantic Ocean, meander through this slightly rolling country. At various points before nearing their outlets some of these streams fail to drain their valleys and swamps of considerable size are formed. The principal streams that empty into the Delaware are drowned at their mouths and have more or less extensive tidal marshes along their courses and about their openings. The country is sparsely wooded until the typical sand is reached where the scrub pine and oak appear.

Woodland pools, owing to limited amount of woodland and the pervious soil are not abundant enough to breed a pest of woodland mosquitoes.

Swamps, on the other hand, are sufficiently numerous to produce a pest of swamp mosquitoes, if they should become active breeders.

The tidal marshes of the various creeks emptying into the Delaware might prove bad breeders of the house mosquito and perhaps of salt marsh mosquitoes, principally *Aedes sollicitans* Wlk. The sewage-charged ones are the most dangerous.

The usual breeding places of the house mosquito are present in perhaps smaller numbers than in places where the soil is less pervious. However, lot pools, roadside pools, stopped-up ditches, holes in the paved streets, water-containing privy vaults, cess-pools, sewer catch-basins, overgrown brooks, ponds, swamps and lakes, unused receptacles, garbage-dump pools, and sewage polluted streams are sufficient in number to produce an unbearable pest at certain points in the county.

Across the Delaware River from Camden County lies a considerable amount of low marsh land on which the white-banded salt marsh mosquito *(A. sollicitans)* has been found breeding during the past season, and it seems reasonable that at times the best sort of mosquito control on the Jersey side will be interfered with by migrants from this source unless the Pennsylvania authorities destroy these breeding places. Judging from the extent of the area, however, it does not seem likely that the interference can be of a very serious nature.

Migrations of the white-banded salt marsh mosquito from the breeding brackish marshes of the coast to the east and its rivers, reach the southeastern section of the county in numbers sufficiently large almost to annul the effect of local work.

THE MOSQUITO PROBLEM OF MIDDLESEX COUNTY.

Middlesex County begins at sea level and stretches westward to its boundary lines. The elevation above the sea is for the most part only 100 feet or less, although in some cases a height of more than double that is reached. The surface of the land is rolling rather than level. The northern part of the county lies on the red shale and to the souhwestward it passes over into a gravelly loam. A part south of the Raritan River below New Brunswick is made up of typical South Central Jersey sand.

Generally speaking, the woodlands are not very extensive, except in the sand barren region. Woodland pools are not sufficiently numerous to produce a serious pest of woodland pool mosquitoes.

The streams which meander through this territory in many cases do not drain all parts of their valleys and a considerable number of swamps are produced. There is reason to anticipate that the control of the swamp species will prove a considerable problem.

In much of this territory, especially in the red shale, the soil is sufficiently impervious to hold water long enough for mosquitoes to breed. The population of Middlesex County is not greatly concentrated hut enough water pollution exists when taken wih the ordinary urban breeding places of the house mosquito to produce a pest of this species in every town of considerable size.

Evidence has been accumulated to show that a considerable pest of malarial mosquitoes is bred along the grassy banks of brooks, swamps, ponds and pools.

It is, however, in the 8,000 acres of salt marsh that Middlesex County has is great mosquito problem. The marsh is divided in many parts and scattered in smaller or larger areas along the coast and tributary streams from the south end to the north end. In the spring the brown salt marsh mosquito *(A. cantator)* and during the summer the white-banded salt marsh mosquito *(A. sollicitans)* breeds on it.

A fairly complete system of drainage has been established in all parts of it and the numbers that now emerge are comparatively small. Under extreme conditions, however, it is conceivable that enough might get out to cause trouble. To get the best results more drains should be cut and the drainage systems patrolled throughout the season.

THE MOSQUITO PROBLEM OF BERGEN COUNTY.

The eastern and western ridges of highland with the Hackensack Valley between, so characteristic of Hudson, continue northeastward into Bergen County. The eastern ridge runs, maintaining its relationship to the Hudson River, to the northeastern border. The western ridge continues almost to Cherry Hill where it bends to the northward and continues in that direction until it finally reaches and joins the broad high lands that extend to the State line. The Hackensack Valley continues northeastward to the State line, forming some swampy lands in the northern part. To the northwestward of this ridge and northeast, east and

southeast of Paterson is an area of comparatively low elevation. To the northwest the county becomes rugged.

There is much wooded territory and many woodland pools—a condition which gives to Bergen County a serious woodland pool mosquito problem.

Many swamps of greater or less size exist, some of which undoubtedly breed the swamp species of mosquitoes prolifically. Bergen County has a swamp mosquito problem of some size. The bulk of the population is located in the southern part of the county, but is not greatly concentrated. The water pollution is, however, sufficient when taken with the usual breeding places of the house mosqnito to furnish every town of considerable size with a pest of that species.

Although our investigations have not yet shown it, there is no reason why places should not occur in this county where the malarial mosquitoes breed as abundantly or more so than any other kind, just as an instance of this sort is known to exist in Sussex County.

In addition to this long roll of fresh water breeding species, Bergen County has in the Hackensack Valley about 9,000 acres of brackish marsh, over which, at certain seasons of the year, much breeding of the brown salt marsh mosquito occurs. Practically no drainage has been established in this area. All drains have been cut by nature or by the land owners. In fact, this area with a few minor exceptions was not recognized as a breeder of salt marsh mosquitoes until the present season, when a careful season-through series of inspections proved it to be so.

As is usually the case, where undrained or partly drained salt marsh exists, the control of the breeding on this area of marsh forms the largest problem with which the county commission will have to deal and one which if not solved will largely annul the effect of upland work.

In the year 1913 the Bergen County Mosquito Extermination Commission was granted by the Board of Chosen Freeholders of that county the sum of $500 for an educational campaign against mosquitoes. The starting of this work was delayed until the money reverted into the treasury and the board refused to reappropriate it for that year.

In the year 1914 this commission was granted the sum of $800 for educational and survey work.

This commissiou, consisting of the president, Mr. H. B. Vannote, of Hasbrouck Heights; the treasurer, Mr. T. M. Brewster, of Ridgefield Park, and of members Mr. Robert Ballagh and Mr. E. B. Walden, of Hackensack, Mr. H. H. Goodwin, of Westwood, and Mr. Wm. D. Tyndall, of Waldick, secured an office in the Court House at Hackensack and employed Mr. Robert S. Cleaver, of Hackensack, as chief inspector.

MOSQUITOES OF THE YEAR.

The occurrence and distribution of the principal species of salt marsh mosquitoes are discussed on pages 401-407 of this report and it will not be necessary to include them in this section. Of the less important, *Aedes tæniorhynchus* Wied., nothing has been said. This species has, however, appeared in small numbers coincidently with *Aedes sollicitans* Wlk.

The season started off witb a small issue of *Aedes canadensis* Theob., accompanied by *Aedes subcantans* Felt, in large numbers. Specimens of botb species were commonly taken in May, but ten *A. subcantans* were captured to one *A. canadensis*. *Aedes sylvestris* Theob. began to appear in late May, and *Coquillettidia perturbans* Wlk. in late June.

Aedes canadensis Wlk. played a very unimportant part in the mosquito fauna of 1914 in the wooded districts of North Jersey south of the mountains. *Aedes subcantans* Felt., on the other hand, proved unusually troublesome and important, being found from May to the middle of July. Ahundant at the beginning of the season, it thinned out until none could be found.

Coquillettidia perturbans Wlk. has this year an unusual record. Appearing in the latter part of June it was present in our collections to the latter part of August. In some localities during this period it was always taken and in some of these places it was at times the dominant and almost the only form. Its occurrence in small numhers was general. There were at least two places wbere it covered a large territory and was present in very considerable numbers. One covered the region of Weequahic Park, and the other the region including and lying east of Brancb Brook Park to the Hackensack River Valley.

Aedes sylvestris Tbeob. was troublesome throughout the past summer. It appeared in May coincidently with the woodland species and remained throughout the season. From the end of June it was the most ahundant of the fresh water species with the exception of the house mosquito.

Culex pipiens Linn., appeared in the collections in June and continued to increase as the season became older until the dry weather of late summer when its numbers fell off. *Culex salinarius* Coq. seems to have been associated with the house mosquito in troubling residences situated near the sewage-charged salt marsh.

Anopheles crucians Wied. maintained its usual standing in Cape May County. *Anopheles punctipennis* Say has been very generally present but always in small numbers. *Anopheles quadrimaculatus* Say has been rather rarely taken in North Jersey south of the mountains. At certain points, however, it appeared in large numbers. At New Brunswick in late summer many were taken. At Fair Haven there was much complaint. In Sussex County in the valley in which Franklin Furnace and Hamburg are located this species was rampant. This valley is in New Jersey's most malarious district.

FINANCIAL STATEMENT OF MOSQUITO WORK.

Total appropriation		$15,000.00
Salt marsh ditching	$7,533.86	
Salary and expenses of Executive Officer	2,063.04	
Inspectors (Herman H. Brehme for 1⅓ months, Henry H. Brehme for 12½ months, Joseph A. Obecny for 5⅙ months, Chas. H. Richardson for 6 months and Chas. S. Beckwith for 5 months)	4,068.41	
aterial, equipment and labor	1,306.29	
Reverting to treasury from October expense requisitions	28.40	
		$15,000.00

Report of the Plant Pathologist.

MELVILLE T. COOK, PH. D.

ORGANIZATION.

The organization of the departments is practically the same as last year except that the term of Mr. Guy West Wilson, Special Agent of the U. S. Department of Agriculture, expired July first. Mr. G. W. Martin, Experiment Station Assistant in Plant Pathology, has devoted the greater part of his time to sulphur dust treatment of apples and peaches for the control of fungous diseases, and to spraying experiments on Kieffer pears for the control of fungous diseases. Mr. C. A. Schwarze, State Board of Agriculture Assistant in Plant Pathology, gave practically all his time in the fall and spring to the inspection of incoming nursery stock. He has also devoted a great deal of time to the study of the "yellows" of the peach and other plants and to the collection of data for a report on the parasitic fungi of New Jersey.

Mr. Edgar L. Dickerson was employed as Special Assistant State Plant Pathologist for the months of July and August to assist with the nursery inspections. His experience in this work makes his services of the very greatest value. Mr. Amos Kirby was assistant inspector for South Jersey from November 1 to December 15, 1913, and Mr. Geo. L. Walters for the same territory during March and April. Both these men were efficient inspectors. Mr. H. Clay Lint, Union Sulphur Company Fellow for the study of the potato scab, devoted practically all of his time to the study of the influence of sulphur on the potato scab.

Mr. Wilson's work on the chestnut blight was in cooperation with the Forest Pathology Laboratory, Bureau of Plant Industry U. S. Department of Agriculture. Mr. Martin's sulphur dust experiments were in cooperation with the Department of Entomology and the Union Sulphur Company. Mr. Schwarze's work on peach yellows was in cooperation with the Department of Horticulture. Mr. Lint's work on the potato scab was in cooperation with the Union Sulphur Company.

NURSERY INSPECTION.

The nurseries of the State have been inspected in accordance with Chapter 54, Laws of 1911, and in most cases were found to be in exceptionally good condition. There is much greater spirit of cooperation between the nurserymen and the Agricultural Experiment Station than in the past. We have received more inquiries concerning plant diseases than at any time in the past and many nurserymen have called our attention to diseases that would otherwise have escaped notice and have asked for assistance in controlling them.

Following the method introduced last year for the reduction of peach yellows in the State, we again cooperated with the Department of Horticulture in offering bud wood to the nurserymen. Twelve nurserymen availed themselves of this offer and buds were distributed as follows:

Willard Apgar, Fairmount, Elberta, Stump, Waddell, Reeves, and Hiley; Bound Brook, Bound Brook, Elberta, Carman, Belle of Georgia, Stump, Greensboro, Frances, Reeves, Lola, Hiley, and Early Crawford; Samuel Brant, Madison, Greensboro, Waddell, Reeves, Lola, Hiley, Gov. Hogg, and May Flower; R. D. Cole, Bridgeton, Elberta, Carman, Belle of Georgia, Stump, Greensboro, Waddell, Frances, Edgemont, Reeves, Lola, Hiley, Early Crawford, and Steven's Rareripe; J. K. Davis, Chester, Greensboro, Waddell, and Hiley; Mansfield Eick, Bissell, Elberta and Frances; Elizabeth Nurseries, Elizabeth, Elberta, Carman, Belle of Georgia, Stump, Greensboro, Waddell, Frances, Edgemont, Reeves, Lola, Gov. Hogg, and Early Crawford; F. & F., Springfield, Elberta, Carman, Belle of Georgia, Stump, Greensboro, Lola, Hiley, Early Crawford and Steven's Rareripe; John F. Leeds, Waterford Works, Greensboro, Frances, and Arp; K. de Waal Malefyte, Ridgewood, Elberta and Early Crawford; Manalapan Nurseries, Englishtown, Elberta, Carman, Belle of Georgia, Stump, Greensboro, Arp, Reeves, Lola, Hiley, Steven's Rareripe, May Flower, Champion, and Early Wheeler; Samuel H. Wilson, Lebanon, Reeves, Lola, and Mt. Rose.

It will be seen that several of these nurseries also received buds a year ago, but the number of requests was not as large as we expected. However, we were not able to supply the full number of buds called for. Next year it will be necessary to limit the number of buds distributed to each nurseryman. This is a rare opportunity for the nurserymen to secure buds true to name and as free from yellows and little peach as it is possible to determine with our present knowledge of these diseases.

INSPECTION OF INTER-STATE AND FOREIGN SHIPMENTS.

The shipment of stock into this State was so large that it was impossible to inspect any considerable amount of it. However, the work was carried forward in cooperation with the Department of Entomology as thoroughly as circumstances would permit.

The dealers in seed potatoes were not as friendly to inspection of potatoes as the nurserymen are to the inspection of nursery stock. And we regret to say that the Exchanges and Granges did not take as much interest in this work as we expected. The quantity of seed potatoes coming into the State was so large and the amount of our funds so small that it was impossible to inspect more than a very small percentage. POWDERY SCAB (*Spongospora subterranea*) was found on two shipments of potatoes from Maine, but thus far we have not found the disease in the growing crops. The SCURF (*Rhizoctonia*) was found in *great abundance* on many shipments but unfortunately its presence did not disturb many of our dealers or growers. *Such disregard for the presence of this and other diseases is costing our farmers many thousands of dollars annually.*

CROWN GALL (*Pseudomonas tumefaciens* S. & T.) and some other diseases were found on a number of shipments of nursery stock. All such diseased stock was condemned and either destroyed or returned

to the consignors. There is an increasing sentiment against crown gall among our nurserymen and growers. The following parasitic fungi were found on foreign nursery stock:—

Volutella buxi on boxwood from Holland; *Exobasidium azaleæ* on Azalea from Belgium; *Mycosphærella fagariæ* on strawberry from England; *Botrytis cinerea* on roses from Holland; *Colletotrichum kentiæ* on Kentia palm from Belgium; *Colletotrichum omnivorum* on Aspidistea from Belgium; *Phyllosticta maculicola* on Dracaena terminalis from Europe; *Diplodia* sp. on orchid from South America; *Penicillium* sp. on Gladiolus bulbs from Holland; *Colletotrichum* sp. on Dacaena canes from West Indies; *Colletotrichum* sp. on Orchids from South America; leaf spot on Rhododendrons from England; twig fungus on English walnut from England; immature fungus on grape canes from England; immature fungus on apple from Holland.

EPIDEMICS.

The only serious epidemic was the "yellows" of the asters. This disease was prealent in a number of places in the State and was the cause of very heavy losses.

Although, with the exception of the aster "yellows," there were no serious epidemics as compared with those of 1913, yet there were many more inquiries concerning diseases of plants and our correspondence was much heavier than ever before, and we were required to make many more personal visits to points throughout the State than in 1913. If this work continues to increase during the next year as during the past two years, it will require the services of one man to devote all his time and attention to answering inquiries and making personal examinations of crops affected with diseases.

INVESTIGATIONS.

The potato investigations consisted of (1) Mr. Lint's work on the influence of sulphur on potato scab, and (2) Dusting and Spraying experiments in cooperation with the Department of Entomology and the Union Sulphur Company. The field tests were conducted by Mr. A. E. Cameron, of the Department of Entomology, and the results are given in the report of that Department.

The apple orchard investigations were restricted to the use of sulphur for the control of fungus diseases and insects, as compared with the recognized standard treatments which are in general use. The Department has also given some attention to the Jonathan spot rot. The pear orchard investigations were for the purpose of determining the most profitable methods of controlling the leaf and fruit spot fungi. The study of the peach "yellows" and "little peach" will be the subject of a bulletin in the near future. The study of crown gall in the nurseries will be continued. It is impossible to make a report at this time. The investigations on diseases of sweet potatoes and cranberries were discontinued for lack of funds.

PUBLICATIONS.

The following publications have been issued during the year:

(1) Press Bulletin No. 8 by the State Board of Agriculture on "Powdery Scab of the Potato" by Mel. T. Cook.
(2) Circular 33 on "Potato Diseases in New Jersey" by Mel. T. Cook and G. W. Martin.
(3) Circular 34 on "Crown Gall and Hairy Root" by Mel. T. Cook.
(4) Circular 35 on "Some Diseases of Nursery Stock" by Mel. T. Cook.
(5) Circular 36 on "Grain Smuts: Their Causes and Treatments" by Mel. T. Cook.
(6) A short paper on "The Jonathan Spot Rot" by Mel. T. Cook and G. W. Martin in Phytopathology 4: 102-105 (1914).
(7) A short paper on "*Cladosporium* Disease of *Ampelopsis Tricuspidatum*" by Mel. T. Cook and Guy West Wilson in Phytopathology 4: 189-190 (1914).
(8) A short paper on "Notes on Economic Fungi" by Mel. T. Cook in Phytopathology 4: 201-203 (1914).
(9) A short paper on "The Southern Bacterial Wilt in New Jersey" by Mel. T. Cook in Phytopathology 4: 277-278 (1914).

NEEDS OF THE DEPARTMENT.

A year ago the writer stated that the greatest need of the Department was for a larger force of men to take up the many problems which are demanding attention. Among the most urgent of these problems are:

(1) The diseases of the tomato. The tomato is one of the most important crops of the State, especially in the southern part. Heavy losses of this crop are due to the Leaf Blight *(Septoria lycopersici)* to Mosaic and to other diseases.

(2) The diseases of the sweet potato. The sweet potato is also an important crop in the southern part of the State. Heavy losses are due to Black Rot (*Sphæronema fimbriatum*) and to the Stem or Yellow Rot.

(3) The diseases of the legume crops. The number of complaints concerning the Root Rot *(Sclerotinia)* of the crimson clover, and other diseases of other legume crops, emphasizes the importance of timely work of this subject.

(4) The "Yellows" of the aster. This disease is causing heavy losses in many localities. It is not well understood and there is no satisfactory treatment.

(5) The diseases of the truck crops. The number of complaints concerning the diseases of truck crops are increasing rapidly and this work is sufficient to take the time of one or more workers.

(6) The diseases of ornamentals. The growing of ornamental plants is a much greater industry than most of ns realize. The number of inquiries from growers of these crops is increasing rapidly and the work demands the attention of competent investigators.

VISITORS.

A number of scientists have visited the Station during the year. Among them we may mention: Dr. R. A. Harper, Professor of Botany in Columbia University; Dr. A. B. Stout, of the New York Botanical Garden; Dr. Haven Metcalf, Dr. W. A. Orton and Professor J. Franklin Collins, of the United States Bureau of Plant Industry; Dr. Otto Appel, Berlin, Germany; Dr. H. T. Gussow, Central Experiment Farms, Ottawa, Canada; Dr. T. F. Manns, Delaware Agricultural Experiment Station.

Alfalfa.

LEAF SPOT (*Pseudopeziza medicaginis* [Lib.] Sacc.). This disease continues to be fully as severe as in the past. There have been

a great many inquiries concerning it and it is no doubt the cause of much greater losses than we realize. There has also been a great deal of complaint concerning a peculiar yellowing of the plants for which we have no satisfactory explanation.

Ampelopsis.

LEAF SPOT (*Phyllosticta ampelopsidis* Ell. & Mart.) This continues to be prevalent on the lower leaves of the plant, but cannot be considered serious except in the nurseries. It attacks both *A. quinquefolia* and *A. tricuspidatum*.

LEAF SPOT (*Sphæropsis hedericola* Speg. & Sacc.). On dead or dying leaves of *A. tricuspidata*. Cannot say that it was the cause of the dying. Collected by Mr. J. P. Helyar. (Also on *Hedera helix*.).

DIE BACK (*Cladosporium* sp.). This disease was much less severe in 1914 than in 1913, which can probably be attributed to the greater amount of rainfall. The disease was especially severe on the ivy on the Rutgers College Buildings in 1913. In the spring of 1914 the vines were given a heavy application of fertilizer and during the entire summer were given an abundance of water. Although the fungus can be found on the old mummy berries, there has been very little evidence of the disease on the vines. A description of this disease was published in Phytopathology 4: 189, 190 (1914).

Apple.

JONATHAN SPOT (*Alternaria* sp.). We are still uncertain as to the cause of this disease, but our studies indicate *Alternaria*. The disease occurred in the orchard and was frequently quite severe in storage.

BLOSSOM END ROT (*Alternaria* sp.). This disease was prevalent. *Alternaria* was very generally found in the diseased fruit and *Sphaeropsis malorum* was frequently associated with it.

ANTHRACNOSE or BITTER ROT (*Glomerella rufomaculans* [Berk.] Spauld. & Von Schenk). There was very little of this disease.

FIRE BLIGHT (*Bacillus amylovorus* [Burr.] De Toni). This very common and well known disease was less severe than in 1913.

SCAB (*Venturia pomi* [Fr.] Wint.). This disease, which has been so severe for the past two years, especially in 1913, was of very little importance. There was not a single complaint from the growers.

BLOTCH (*Phyllosticta solitaria* E. & E.). Common, especially on Smith cider, but not so abundant as in 1913.

SPRAY INJURY. A few complaints.

RUST (*Gymnosporangium macropus* Lk.). Occasional. No importance.

WINTER INJURY. A few reports.

WATER CORE. A few reports on fall pippin.

PINK ROT (*Cephalothecium roseum* Cda.). A few reports. Not important.

CROWN GALL (*Pseudomonas tumefaciens* S. & T.). Abundant throughout the State. Found to be very destructive on William Early Red eight-year old orchard.

BLACK ROT (*Sphaeropsis malorum* Pk.). Common and severe on unsprayed orchards.

SOOTY BLOTCH (*Leptothyrium pomi* [Mont. & Fr.] Sacc.). Abundant on unsprayed orchards.

Ash.

DIE BACK (cause undetermined). In forest nursery on the College Farm.

Aster.

RUST (*Coleosporium solidaginis* [Schw.] Thum.). One report.

YELLOWS. This disease was so severe as to be an epidemic in many localities. It was the cause of heavy losses.

Beans.

MILDEW (*Phytophthora phaseoli* Thaxter). Severe on lima beans in Middlesex and Warren counties during July and August.

ANTHRACNOSE (*Colletotrichum lindemuthianum* [S. & M.] B. & C.). Abundant throughout the State.

POD BLIGHT (*Phoma subcircinata* E. & E.). Severe on lima beans throughout the southern part of the State.

LEAF SPOT (*Phyllosticta phaseolina* Sacc.). Common throughout the southern part of the State.

Beet.

LEAF SPOT (*Cercospora beticola* Sacc.). Common.

Blackberry.

ANTHRACNOSE (*Gloeosporium venetum* Speg.). Common but of no great importance.

LEAF SPOT (*Septoria* rubi West.). Commou but of no great importance.

RUST (*Gymnoconia peckiana* [Howe] Tranz). Common throughout the State. Some reports indicate that it was very destructive.

Boxwood.

LEAF AND STEM DISEASE (*Volutella buxi* [Cda.] Berk.). Found quite severe in one nursery.

Cabbage.

CLUB ROOT (*Phasmodiophora brassicæ* Wor.). Reported from various parts of the State and quite severe in some places.

BLACK ROT (*Pseudomonas campestric* [Pamm.] E. F. Smith.). Occurs in northern part of the State.

Catalpa.

LEAF SPOT (*Cercospora* Wint.). Common.

LEAF SPOT (*Phyllosticta catalpæ* E. & M.). Common.

Cannas.

YELLOWS. A peculiar disease causing a variegation of foliage and dwarfing of plants found in one nursery.

Carnation.

RUST (*Uromyces caryophyllinus* [Schrk.] Schroet). Very common.

BUD ROT (*Sporotrichum anthophilum* Peck). One report.

Cauliflower.

CLUB ROOT (*Plasmodiophora brassicæ* Wor.). One report.

Cedar.

LEAF SPC

disease continues *porangium macropus* Lk.). Common but not abundant.

Celery.

BACTERIAL ROT (*Bacillus carotovorus* Jones). Very severe in the northern part of the State.
LEAF BLIGHT (*Cercospora apii* Fr.). Abundant.
LEAF BLIGHT (*Septoria petroselini* var. *Apii*). Abundant.
HOLLOW STEM (Cause?). One report.

Chard.

LEAF SPOT (*Cercospora* sp.). One report.

Cherry.

BROWN ROT (*Schlerotinia fructigena* [Pers] Schr.). Not severe.
LEAF SPOT (*Cylindrosporium padi* Karst.). Common.
MILDEW (*Podosphæra oxyacanthæ* [D. C.] D. By.). One report.

Chestnut.

BLIGHT (*Endothia parasitica* Murrill). Abundant.

Citron.

LEAF SPOT (*Cercospora citrullina* Cke.). One report.

Clover.

LEAF SPOT (*Pseudopeziza trifolii* [Pers.] Fckl.) on red clover. One report.
ROOT ROT (*Sclerotinia trifoliorum* Erik). Reported.

Corn.

SMUT. (*Ustilago zeæ* [Beckm.] Ung.). Common.
WILT (*Pseudomonas stewarti* E. F. Smith). Several reports.

Cow Pea.

LEAF SPOT (*Cercospora* sp.). Common.

Crab (Flowering.)

RUST (*Gymnosporangium germinale* [Schw.] Kern.). One report.

Cucumber.

MILDEW (*Plasmopara cubensis* [B. & C.] Humph.). Common.

Currant.

ANTHRACNOSE (*Gloeosporium ribis* [Lib.] Mont. & Desm.). Common.
LEAF SPOT (*Septoria ribis* Desm.). Common.

Dahlia.

DWARFING (Cause unknown). One report. Somewhat similar to yellows.

Dewberry.

ANTHRACNOSE (*Gloeosporium venetum* Speg.). Common but of no importance.
DOUBLE BLOSSOM (*Fusarium rubi* Wint.). Abundant and injurious.
LEAF SPOT (*Septoria rubi* West.). Common.
RUST (*Gymnoconia peckiana* [Howe] Franz). Common.

Egg Plant.

LEAF SPOT (*Phyllosticta hortorum* Speg.). Abundant throughout the State.

WILT (Cause?). Abundant throughout the State.

Grape.

BLACK ROT (*Guignardia bidwellii* [Ell] Viola & Ravaz). Abundant and cause of heavy losses in some places.

LEAF SPOT (*Isariopsis clavispora* Sacc.). In one vineyard on Elvira. Very severe.

LEAF SPOT (*Cryptosporella viticola* Shear.). One record. Not serious.

MILDEW (*Plasmopara viticola* [B. & C.] B. & DeT.). Abundant but not serious.

FRUIT ROT (*Phoma* sp.). One record.

SPRAY INJURY. Two records.

Hollyhock.

RUST (*Puccinia malvacearum* Mont.). Common.

Horse Chestnut.

LEAF SPOT (*Phyllosticta sphæropsidea* E. & E.). Common.

MILDEW (*Uncinula flexnosa* Pk.). Occasional.

Larkspur.

WILT. Unidentified sclerotial fungus. One report.

Lilac.

LEAF SPOT (*Phyllosticta halstedii* E. & E.). Common.

MILDEW (*Microsphaera alni* [Wallr.] Wint.). Common.

Maple.

ANTHRACNOSE (*Gloeosporium apocryptum* E. & E.). On Norway maple. Serious on young trees in the nursery.

BARK DISEASE (*Nectria cinnabarina* or *N. coccinea.*). Tubercularia stage only. One report.

LEAF SPOT (*Phyllosticta acericola* C. & E.). On soft maple. Common.

Oats.

SMUT (*Ustilago levis* [K. & S.] Magnus). Common.

SMUT (*Ustilago avenæ* [Peri.] Jens). Common.

RUST (*Puccinia coronata* Cda.). Common.

Okra.

WILT. (*Verticillium* sp.). Common in South Jersey.

Peach.

BROWN ROT (*Sclerotinia fructigena* [Pers] Schr.). Abundant in unsprayed orchards.

CROWN GALL (*Pseudomonas tumefaciens* S. & T.). Common. Trees affected with this disease appear to be more subject to other diseases than healthy trees.

LEAF CURL (*Exoascus deformans* [Berk] Fuckel). Abundant in orchards which were not properly sprayed.

LITTLE PEACH. Abundant and cause of heavy losses over the State.

SCAB (*Cladosporium carpophilum* Thum.). Abundant in unsprayed orchards.

SHOT HOLE (*Bacterium pruni* E. F. Smith). Abundant in certain localities of South Jersey. Most severe on Elbertas.
SHOT HOLE (*Cercospora circumscissa* Sacc.). One report.
SPRAY INJURY. Common.
WINTER INJURY. Common.
YELLOWS. Abundant and the cause of heavy losses.

Pear.

FIRE BLIGHT (*Bacillus amylovorus* [Burr] De T.). Less severe than in 1913.
FRUIT SPOT (*Fabræa maculatum* [Lev.] Atk.). Common.
LEAF SPOT (*Septoria pyricola* Desm.). Common. Not serious.
SCAB. (*Venturia pyrina* Aderh.). Common.

Pepper.

FRUIT ROT (*Colletotrichum nigrum* E. & H.). Common.
FRUIT ROT (*Gloeosporium piperatum* E. & E.). Common.
ROOT ROT (Cause?). Common.

Pine.

ROOT DISEASE (*Mycorhiza*). Common.

Plane Tree.

ANTHRACNOSE (*Gnomonia veneta* [S. & S.] Kleb.). Common.

Plum.

BROWN ROT (*Sclerotinia fructigena* [Pers.] Schr.). Abundant in unsprayed orchards.
LITTLE PLUM. Common.
BLACK KNOT (*Plowrightia morbosa* [Schw.] Sacc.). Common.

Popular.

CANKER (*Rhabdospora* sp.). One report. Causing die back of twigs.
BLIGHT (*Marsonia populi* [Lib.] Sacc.). One report.

Potato.

BLACK LEG (*Bacillus phytophthorus* Appel.). Much less than in 1913.
EARLY BLIGHT (*Alternaria solanii* [E. & M.] Jones & Grout.). Common.
LATE BLIGHT (*Phytophthora infestans* [Mont.] De Borg.). Two records on seed potatoes in spring. Very abundant in North Jersey in the fall.
CURLY TOP. Frequent. This is the first report of this disease in New Jersey.
DRY ROT (*Fusarium oxysporum* Schl.). Occasional.
SCAB (*Oospora scabies* Thax.). Abundant.
SILVER SCURF. (*Spondylocladium atrovirens* Appel & Laubert.). Occasional.
SCURF (*Rhizoctonia* or *Corticium vagum* B. & C. O. var. *Solani* Burt.). Abundant.
SPRAY INJURY. Frequent.

Quince.

BLACK ROT (*Sphæropsis malorum* Pk.). Common.
FIRE BLIGHT (*Bacillus amylovorus* [Burr.] De T.). Common but less severe than in 1913.
LEAF SPOT (*Fabræa maculatum* [Lev.] Atk.). Common.
RUST (*Gymnosporangium germinale* [Schw.] Kern.). One record.

Raspberry.

ANTHRACNOSE (*Glœosporium venetum* Speg.). Abundant and frequently severe.

CANE BLIGHT (*Cytospora rubi.* Schw.). One record.

CANE BLIGHT (*Coniothyrium fuckelii* Sacc.). Common and very severe in northern part of the State.

CROWN GALL (*Pseudomonas tumefaciens* S. & T.). Abundant and severe.

LEAF SPOT (*Septoria rubi* Westd.). Abundant.

Rose.

BLACK SPOT (*Actinonema rosæ* [Lib.] Fr.). Abundant.

CANE BLIGHT (*Coniothyrium fuckelii* Sacc.). Severe in northern part of State.

MILDEW (*Sphærotheca pannosa* [Wllr.] Lev.). Very common.

INTUMESCENCE. One report on roses under glass. Probably due to application of sulphur. Not serious.

Snap Dragon.

ROOT ROT (*Thielavia basicola* [B. & Br.] Zopf.). One record. Cause of serious loss.

Strawberry.

LEAF SPOT (*Mycosphærella fragariæ* [Tull.] Lindau.). Common.

Sunflower.

RUST (*Puccinia helianthii* Schw.). Common.

Sweet Potato.

BLACK ROT (*Sphæronema fimbriatum* [E. & H.] Sacc.). Abundant.

STEM ROT (*Fusarium batatatis* Wollenw)*. Abundant.

Tomato.

ANTHRACNOSE (*Colletotrichum phomoides* [Sacc.] Chester). Abundant and destructive.

BLOSSOM END ROT. (Cause?). Less common than in 1913.

FILIFORM LEAF. Occasional.

LEAF SPOT (*Septoria lycopersici* Speg.). Abundant and the cause of heavy losses.

WILT (*Fusarium lycopersici* Sacc.). A condition of plants which indicates this disease.

Turnip.

LEAF MOLD (*Macrosporium herculeum* E. & L.). One record.

Watermelon.

ANTHRACNOSE (*Colletotrichum lagenarium* [Pass] E. & H.). Abundant in southern part of the State.

Wheat.

RUST (*Puccinia graminis* Pers.). Common.

SMUT (*Ustilago tritici* [Pers] Jens.). Common.

SMUT (*Tilletia fœtens* [B. & C.] Trel.). Occasional.

In addition to the above list, our records show a very large number of diseases of minor importance on ornamentals and wild plants.

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*This disease was formerly attributed to *Nectria ipomœa* Hals.

Report of Potato Scab Experiments, 1914.

By H. CLAY LINT.

The investigations of the Department of Plant Pathology relating to potato scab have been confined largely to the testing of materials used to aid in the control of the disease. The disease is caused by the definite fungus *Actinomyces scabies** Thaxt., Gussow. It is very widely distributed in all of the potato growing sections of New Jersey, and in many places the attack is so severe as to render a portion of the yield unsaleable. The disease is especially severe on the Green Mountain and Irish Cobbler varieties. On the American Giant, a variety cultivated in the middle sections of Jersey, the scab seldom develops so far as to render many of the tubers unsaleable. In many sections it is desirable to grow this crop on the same soil for a number of years and in these localities the scab is a problem of considerable economic importance.

There are two methods of attacking this disease: *First*, an effective treatment of the seed so as to eliminate this source of infection. *Second*, a soil treatment in cases where the soil has become infected with the organism.

The first effective treatment of the seed potatoes was accomplished by Bolley (1) by means of soaking the seed potatoes in an aqueous solution of corrosive sublimate ($HgCl_2$). Shortly afterward Arthur (2) introduced the formalin treatment of the seed potatoes. This likewise consists in soaking the seed, the standard strength recommended at the present time being one pint of 40 per cent. formalin solution to 30 gallons of water. The period of soaking should extend from one and one-half to two hours.

Experimental tests and practical experiences have long ago demonstrated the effectiveness of both of these treatments. For the scab alone there is little difference either in effectiveness or cost between the two methods of treatment. Recently evidence has been presented to show that the corrosive sublimate is more effective against the potato scurf (*Rhizoctonia* or *Corticium vagum* var. *solani*) than formalin. The former is, however, a deadly poison and not to be recommended to those who are not familiar with its properties. Because of the equal effectiveness of these substances in the control of scab and because of the danger attendant upon the use of corrosive sublimate, the Department has generally recommended the formalin.

Seed treatment is very generally recognized in this State as a profitable practice.

Dr. Halsted (3) of this Station tried out a number of materials for the control of the potato scab organisms in the soil during the interval from 1895 to 1900. The most promising proved to be sulphur. He used various rates of application, obtaining best results with amounts of about 600 pounds per acre. Considering the favorable nature of the results and the

*Sym. *Oopora scabies* (Thaxt.)

opportunities that this work presented for further study, this line of investigation has been taken up again. This work has been made possible through an industrial fellowship established in this Department by the Union Sulphur Company of New York City.

Many investigators, both in this country and abroad, have employed sulphur for the purpose of scab eradication; the results vary widely and are sometimes contradictory.

Brooks (4) at Massachusetts tried out sulphur in much the same manner as was done in this State. He failed to obtain any appreciable benefits from its use, the average increase in the clean potatoes being around six per cent.

Wheeler (5) and collaborators at Rhode Island tried out a large number of materials, including sulphur, for scab control. Only small benefits resulted from the use of sulphur with the potatoes and it was found that on soils which were acid or only slightly alkaline there was a distinct injurious effect on the succeeding crops.

In 1910-11 Bernhard (6) at Ahrvilles (France) published results which showed the sulphur to be very effective in the control of scab. E. Boullanger (7) at Lille (France) investigated the fertilizing action of sulphur on various crops, including potatoes, and found an increase in the yield of 20 per cent. due to applications of sulphur. M. A. Demolon (8) and E. Chancrin and A. Desroit (9) likewise report an increased yield due to applications of sulphur to potatoes. These latter used sulphur at the rate of 250 and 500 Kg. per hectare, equivalent to 223 and 445 pounds per acre, respectively.

J. Veicier (10) in 1913 reported an increased yield due to applications of sulphur, also an earlier maturity of the crop from six to eight days. Hialmar von Feileitzen (11) at Jonkoping in Sweden reports favorable results in scab control from applications of sulphur in the case of some varieties but finds an injurious effect on the succeeding crops.

EXPERIMENTS IN NEW JERSEY IN 1914.

In considering the problems connected with the application of sulphur there appear at once a number of factors which cannot but have a material influence on the efficiency of the fungicide. Our lines of investigation, therefore may be stated.

First: The influence of cover crops on the control of scab accomplished by sulphur. Where growers care to produce crops of potatoes on the same soil for a number of years, the common practice is to sow a cover crop each year. This is ordinarily planted as soon after the digging as possible. Crimson clover, either alone or in mixture with a non-legume, has become very popular for this purpose within recent years.

Second: The influence of the time of application of the sulphur. It was noticed that at digging time a great proportion of the sulphur which had been applied in the spring was present in the soil, apparently unchanged. Such evidence would tend to show that the oxidation of the sulphur under the conditions of the soil was being accomplished very slowly. If the fungus control is accomplished because of the sulphuric acid formed by the oxidation of the sulphur, it would appear possible to obtain better results by making the application in the fall, thus giving a longer time for changing the nature of the element in the soil. Based on these observations, we have tried out fall versus spring application of the sulphur.

Third: The influence of the formalin treatment of seed potatoes, on the control of the scab. In this connection we have used the formalin alone as a combatting measure, as we recommend to the growers. In the formalin tests we have run plots which received applications of sulphur so that we have data not only on each of the preventative measures but also on the combination of the two.

Fourth: The influence of the method of application. In the experimental work that has been done with sulphur quite a number of different methods of application have been used. Some would be highly impracticable on a large scale so that in our work we have tested out the influence of three methods of application which are possible on a commercial scale. They are: (a) Broadcasting the sulphur. With this method the comparison was made of application before and after planting. (b) Mixture of the sulphur with the fertilizer. (c) Placing the sulphur in a narrow strip on top of the row after the time of planting.

Fifth: The inflnence of the form in which the three essential elements, Nitrogen, Phosphoric Acid and Potash, are found in the fertilizer. Upon this phase of the problem we have compared: (a) Sulphate of potash with muriate of potash as a source of potassium. (b) Acid phosphate with steamed bone as a source of phosphoric acid. (c) Nitrate of soda with ammonium sulphate as a source of nitrogen.

A number of experiments have been conducted on different soils in various parts of the State to determine the varying results dependent on the texture, origin and past treatments.

No potato growers with whom the Experiment Station is in touch attempt to grow a crop without fertilizer. The common formula of the fertilizer used is 4-8-10 and the rate of application will range between 1,200 pounds and one ton per acre. In our work we have been unable to compare the effectiveness of the sulphur with and without fertilizer.

The various points outlined above have been covered by 18 different experiments ranging in size from 3 to 18 plots each, as follows: Cumberland County, 5 experiments; Salem County, 5 experiments; Gloucester County, 2 experiments; Mercer County, 1 experiment; Moumouth County, 3 experiments; Middlesex County, 1 experiment; Sussex County, 1 experiment.

In general, our ideal has been to employ plots of at least one-fifth of an acre in size and at least five rows wide. Where the length of the field has been over 600 feet, we were able to carry out this plan. In cases where the row length is less than 600 feet, we have compensated by increasing the plot width. In some of our experiments the plot areas have been as large as one-half acre. We have insisted on at least five rows so that the middle rows would not be influenced by outside conditions.

Only the two middle rows of each plot were used for obtaining data. The potatoes were sorted into clean and scabbed in cases where the entire yield was saleable. In others we have formed a third class of unsaleable scabbed potatoes. In our experiments, especially when the scab is very severe, the data shows relative scab rather than absolute numbers of clean and scabbed potatoes. For instance, in one experiment where 25 per cent. of the yield was unsaleable because of scab. In this field it is entirely probable that there was not one potato free from scab; yet under these conditions one finds a larger number of potatoes on the

sulphur plots that have but a few scab spots than on the check plots, it is fair to attribute this condition to the sulphur. Under the old methods of grading into clean and scabbed all plots would be 100 per cent. scabby with no comparative results.

The opposite conditions prevailed in some of our experiments, where as high as 85 per cent. were absolutely clean. In this case the minutest lesions were enough to discard the tuber from the class of clean potatoes. It will be readily seen that our scale has been flexible, depending upon the amount of scab present, but that in sorting the potatoes from any one experiment that the standard has been fixed.

That the yields might have a more impressive character we have figured them into bushels per acre rather than into pounds per plot. The per cents. of each are figured from the actual weights of clean and scabbed potatoes.

The influence of the various factors on the effectiveness of the sulphur are considered separately.

I. Influence of cover crop.

(a) On the yield. The results of this year's experiments have shown very remarkable increases in the yields due to the growth of a cover crop. An average of the yields from all the non-cover crop and cover crop plots in four experiments is given in the following table:

YIELDS IN BUSHELS PER ACRE.

Farm of	Post-office.	Cover crop plots.	No cover crop.
D. H. Jones	Freehold	244.9	221.5
Elbert Kirby	Mullica Hill	215.1	195.8
J. L. Bitters	Roadstown	117.6	96.6
J. H. DuBois	Freehold	276.2	254.3
Total		853.8	768.2
Average		213.45	192.05

Average increase due to cover crop, 21.4 bushels.

(b) Regarding the influence of the cover crop on the efficiency of the sulphur we find that the sulphur does not increase the per cent. of clean tubers as much on the cover crop plots as on the non-cover crop plots. On the farm of John H. DuBois at Freehold we found 39.95 per cent. of clean potatoes on a cover crop check plot with 48.20 per cent. of clean tubers on the corresponding sulphured plot. This gives an increase of 8.25 per cent. of clean potatoes due to sulphur application. On the non-cover plot areas the check shows 45 per cent. clean potatoes, while the corresponding sulphured plot shows 63.45 per cent. of clean potatoes. Here the increase in the number of clean potatoes is 18.45 per cent. In other words the sulphur is a little better than twice as effective on non-cover crop soil as on soil which has just previously grown a cover crop.

Even more striking results were obtained on the farm of D. Howard Jones, whose potato field under experiment lies less than a quarter of a mile from the DuBois farm and has the same type of soil. On the non-cover crop plots the sulphur increased the per cent. of clean tubers from 35.90 to 59.08, a difference of 23.18 per cent. On the cover crop plots the increase was only 4.61 per cent. The sulphur here was about five times as effective on the non-cover cropped areas.

II. Influence of time of application on the efficiency of the sulphur.

(a) Our experiments with fall versus spring applications have shown very clearly that the spring application is much more efficient, especially on soils where there has heen no cover crop grown. The following experiment will serve to illustrate this point:

EXPERIMENT WITH D. H. JONES, FREEHOLD, N. J.

Plot treatment.	Per cent. clean tubers.	Bushels per acre.
Check, no sulphur	47.66	244.5
Sulphur broadcasted in fall	52.27	259.8
Check, no sulphur	47.66	239.5
Sulphur broadcast in spring	74.57	226.3

This experiment shows an increase in the number of clean potatoes of 4.61 per cent. due to fall application as compared with a difference of 26.91 per cent. due to spring application. These results are also interesting from the yield standpoint where the fall application gives an increased yield of 15.3 bushels per acre over its check, while the spring application gives a decrease of 13.2 bushels per acre. It is true that we find a normal variation of five bushels per acre in the yield on the two checks, but where the differences are nearly three times the normal variation they must be attributed in part to the varying factor, which in this case is the time of sulphur application.

(b) Another phase of the prohlem of time of application presents itself. On the farm of E. C. Conover, at Freehold, which lies near that of D. H. Jones and has the same type of soil, there was obtained a 26.52 per cent. increase in the number of clean potatoes due to applications of sulphur. At the Jones farm, as before stated, the difference obtained was 27 per cent. In the former case the sulphur was applied the first day of June and in the latter the application was made April 18th. Whether or not the time for spring application extends over so long a time with the possibility of equally good results is well worthy of further study.

III. Influence of formalin treatment of the seed in the control of the potato scab.

For all of our experiments this year we have tried to select a soil that was badly contaminated with the scab organism. Obviously it is much more difficult to show benefits of seed treatment in cases where the soil is infected, because only one of the sources of infection has been removed. On this point Sherbakoff (12) states that "When the soil becomes contaminated with the scab germ, seed treatment is of no value unless some method can be devised for eradicating the germ in the soil." Despite the fact that our experiments with seed treatment have been run under just such adverse conditions as outlined above, we have been ahle to show beneficial results from three standpoints.

(a) Influence of the formalin treatment on the scab control.

An average of two check plots with formalin treated seed gives 19.10 per cent. clean potatoes as compared with an average of 14.99 per cent. with untreated seed. These results were obtained in cooperation with Mr. Robert Fogg at Salem, N. J., on soil that was badly infested with the organism. The above point is also illustrated in the table given below

from the data obtained in our experiment with Clifford Flitcraft at Elmer. Here we have 28.45 per cent. clean potatoes on plots seeded with untreated tubers against 37.95 per cent. clean potatoes from the formalin treated seed.

(b) Influence of the combined sulphur and formalin treatments.

By a combination of the formalin treatments of the seed and the sulphur treatment of the soil we have been able to obtain data that are very favorable both to the formalin and the sulphur. Data from four plots of one experiment with Mr. Flitcraft at Elmer will serve to illustrate this point.

Plot No.	Sulphur.	Seed	Per cent. clean.	Per cent. unsalable.
1.	600 lbs. per acre	Untreated	57.40	3.35
2.	Check, no sulphur	Untreated	28.45	23.52
3.	Check, no sulphur	Treated	37.95	13.51
4.	600 lbs. sulphur per acre	Treated	74.80	4.93

Comparison of plots 2 and 3 show not only 9.5 per cent. more clean potatoes due to formalin treatment, but also 10 per cent. less unsaleable tubers. The fact that nearly one-fourth of the crop was unsaleable because of scab on the plot where no treatment was given proves beyond question that there was bad infestation of the soil. Such marked benefits from the formalin treatment under these adverse conditions exceeded our expectations.

With regard to the sulphur it is interesting to note how much more effective the sulphur has been in the case of the formalin treated seed. A comparison of plots 1 and 2 shows a difference of 28.95 per cent. in the number of clean potatoes due to the sulphur application. A similar comparison of plots 3 and 4 gives a difference of 36.85 per cent. Obviously the sulphur is much more efficient where it has only the scab in the soil with which to contend. From the practical standpoint the sulphur here has been very beneficial in that it has rendered practically the entire yield saleable where one-fourth of the yield would otherwise have been unmarketable.

(c) Influence of the formalin treatment on the yield.

It has been the experience of a number of growers that formalin treatment has given larger yields. The reason for this is not satisfactorily explained to date although the fact is pretty well established. These averages of six plots on the farm of Robert Fogg, Salem, N. J., with formalin treatment as compared with six plots entirely similar save that they were planted with untreated seed gives the following results:

Average yield for formalin treated seed, 138.4 bushels per acre.

Average yield for non-treated seed, 133.6 bushels per acre.

In other words, one can figure on enough increase in the yield due to formalin treatment to pay for the material and labor.

IV. The influence of the method of application on the efficiency of the sulphur.

Our tentative conclusions of this phase of the sulphur question may be summed up as follows: (1) Broadcasting of the sulphur has given slightly better results than the mixture of the sulphur with the fertilizer. (2) Broadcasting of the sulphur after planting gives better results than broad-

casting before planting. In the latter case the sulphur becomes well integrated in the surface soil which inhibits the rapid oxidation possible where the sulphur is not so mixed. (3) The application of sulphur in a narrow strip on top of the rows after planting has given better control of the scab than broadcasting at this time. In this method the amount of application is practically doubled since only half of the surface of the soil is covered. Linked with the higher efficiency of the sulphur due to this method of application we find the greatest decreases in yield.

Undoubtedly, the most convenient method of applying sulphur to the soil would he to have it mixed with the fertilizer. Our work would tend to show that the best place to have the sulphur is near the surface of the soil and with some types of distributers the fertilizer is placed below the level of the seed piece. Obviously, the fungicidal effect of the sulphur in this place is much impaired. More recent fertilizer attachments of potato planters put the fertilizer near the surface and above the seed piece and the results at Freehold this year in which the mixture of fertilizer and sulphur was applied with this type machine showed almost as good control as did broadcasting. From the evidence at hand on this point it is doubtful whether the slightly better results from broadcasting over mixture with the fertilizer will compensate for the extra labor involved.

V. Influence of the form of the fertilizer elements on the efficiency of the sulphur.

In all of the experiments covering this phase of the work we have used 1,400 pounds of complete 4-8-10 fertilizer per acre. They were made up exactly alike save for the one element in question: acid phosphate versus steamed hone in the one case, $NaNO_3$ versus $(NH_4)_2SO_4$ in another and KCl versus K_2SO_4 for the third. Tentative conclusions on the phase of the sulphur problem follow:

(a) Sulphur makes a larger increase in the per cent. of clean potatoes with KCl than with K_2SO_4. This is illustrated in the following table of results obtained on the farm of Joseph Fogg at Bridgeton, N. J.:

Fertilizer.	Treatment.	Per cent. clean.	Per cent. unsalable.
KCl	Check, no sulphur	11.94	8.30
K_2SO_4	Check, no sulphur	10.82	0.61
KCl	300 lbs. sulphur per acre	23.07	0.655
K_2SO_4	300 lbs. sulphur per acre	13.67	1.63
KCl	600 lbs. sulphur per acre	27.70	1.93
K_2SO_4	600 lbs. sulphur per acre	20.65	1.40

(b) Sulphur seems to have a greater fungicidal effect with acid phosphate than with steamed bone as a base in the fertilizer. This is shown in the following table:

Fertilizer.	Treatment.	Per cent. clean.	Per cent. unsalable.
Steamed bone	Check, no sulphur	20.00	6.42
Acid phosphate	Check, no sulphur	11.94	8.30
Steamed bone	300 lbs. sulphur per acre	20.55	2.74
Acid phosphate	300 lbs. sulphur per acre	23.07	0.655
Steamed bone	600 lbs. sulphur per acre	26.48	2.56
Acid phosphate	600 lbs. sulphur per acre	27.70	1.93

(c) Sulphur makes a much greater increase in the cleanliness of the potatoes in combination with $(NH_4)_2SO_4$ than with $NaNO_3$. This point is illustrated by the following results:

Fertilizer.	Treatment.	Per cent. clean.	Per cent. unsalable.
$NANO_3$	Check, no sulphur	9.75	0.00
$(NH_4)_2SO_4$	*Check, no sulphur*	*9.75*	0.00
$NaNO_3$	300 lbs. sulphur per acre	20.90	0.00
$(NH_4)_2SO_4$	*300 lbs. sulphur per acre*	*31.00*	0.00
$NaNO_3$	600 lbs. sulphur per acre	28.18	0.00
$(NH_4)_2SO_4$	*600 lbs. sulphur per acre*	*35 30*	0.00

VI. *Influence of the rate of application.*

In general we have been able to obtain but little decrease in the amount of scab due to applications of 300 pounds of sulphur per acre. The results from applications of 600 pounds of sulphur have in some cases been very remarkable. The results of Series "D" experiments with Minch Brothers at Bridgeton, N. J., show the best scab control obtained in any of our experiments.

Plot No.	Sulphur treatment.	Per cent. clean.	Per cent. medium scabbed.	Per cent. unsalab e.
1.	600 lbs. sulphur per acre	55 10	44.60	00.30
2.	Check, no sulphur	00.30	89.10	10.60
3.	300 lbs. sulphur per acre	5.10	91.20	3.70

In order to illustrate the average result to be expected from the application of sulphur in these two rates, the averages of the plots of the following experiments are cited and the general average taken. In all these experiments we have plots with 300 pounds sulphur per acre, 600 pounds sulphur per acre and the corresponding checks. The table of averages follows:

Cooperation with	Post Office.	No. plots in the experiment.	Per cent. clean on check plots.	Per cent. clean on 300 lbs. sul. per acre plots.	Per cent. clean on 600 lbs. sul. per acre plots.
E. C. Conover	Freehold	3	32.18	34.40	58.70
Jos. H. Fogg	Bridgeton	18	15.05	26.52	27.03
Minch "D"	Bridgeton	3	00 30	5 10	55.10
Edw. Ackerson	Lafayette	8	82.48	85 35	86.65
Elbert Kirby	Mullica Hill	9	29.60	41.44	50 20
Flitcraft "A"	*Elmer*	7	38.92	49.44	57.15
Minch "B"	Bridgeton	12	4.53	9.78	9.44
Minch "A"	*Bridgeton*	*12*	*15.38*	*22.66*	*22.38*
John Ballinger	Mullica Hill	9	13.81	25 52	35.51
Total		...	232.25	300.22	402.16
Average			*25.80*	*33.36*	*44.57*

The influence of the sulphur on the yield has been somewhat varied. This influence seems to depend a great deal upon th acidity of the soil, also upon the texture. Most potato soils are acid, the lime requirement ordinarily varying from 800 to 1,800 pounds of CaO per acre. It is not difficult to understand that a decrease in the yield might result purely because of too acid conditions of the soil when the sulphur is added under such circumstances. In general the application of sulphur has resulted in a decrease in the yield. However, the data cited below where the sulphur produced an increased yield will show within how wide a range the results in this particular line may vary. The following table shows the results of an experiment on the farm of C. W. Stevens, Jr., on the red

Plot No.	Sulphur Treatment.	Yield in Bushels *per acre.*
1	Check	41.10
2	300 lbs. sulphur per acre	59.40
3	600 lbs. sulphur per acre	51 35
4	900 lbs. sulphur per acre	59 80

Here we find an increase of about 30 per cent. in the yield in two out of three of the sulphur plots. This soil is strictly speaking not a potato soil and has not been subjected to the treatments accorded the normal potato soils. This soil is also very nearly neutral, another item which is contrary to the normal condition in potato soils. It has been our experience that the danger of injury from the sulphur is much more prevalent on a light soil than on the heavier types.

To get at the average and normal result to be expected on the yield from the application of sulphur, we have prepared the following table of average yields from eight of the experiments used in making the per cent. of scab table. These averages follow:

	YIELDS IN BUSHELS PER ACRE.		
In cooperation with	On checks.	300 lbs. sul. plots.	600 lbs. sul. plots
E. C. Conover	388 0	375 0	360.5
Joseph Fogg	82.75	87.35	85.1
Edw. Ackerson	*166.2*	*164.1*	*152 2*
Elbert Kirby	220.0	207 8	196.4
Flitcraft "A"	99 87	99.4	100.97
Minch Bros. "A"	123 3	123 3	138.6
Minch Bros. "B"	149.4	137 8	143.4
John Ballinger	166.6	133 5	141.85
Total	1398.12	1327 9	1319 02
Average	174 74	165 98	164 88

Many other points of interest have been noted in connection with the sulphur work that have not been brought out in the data previously cited. On two out of fonrteen experiments started in the summer of 1913 by John H. Voorhees, of the Extension Department, but later turned over to the Department of Plant Pathology, we have found injury to the succeeding hay crop. On the farm of R. M. Dilatush at Robbinsville and that of Frank Ridgeway at Woodstown the sulphur rows were marked entirely across the field by the absence of vegetation. The evidences of this injury disappared slowly and by the fall of 1914 no traces of the injury remained.

Acidity determinations of the soil from Mr. Dilatush's farm gave the following results:

Row Numbers.	Lime requirement in pounds CaO per acre.
Row 1—Check	883
Row 2—300 lbs. sulphur per acre applied	2247
Row 3—600 lbs. sulphur per acre applied	3025
Row 4—300 lbs. sulphur per acre applied	2590
Row 5—600 lbs. sulphur per acre applied	3187

Crimson clover seems particularly susceptible to injury and in most instances the injury can be attributed to the high acidity of the soil.

Showing detrimental effect on the succeeding hay crop on the farm of Frank Ridgeway at Woodstown, N. J. The Sulphur was applied in mixture with the fertilizer and bare streaks show the position of potato rows.

Another fact noted on sulphur plots is that the skins of the potatoes are almost invariably lighter in color, and presumably finer in texture. Even where there is no scab present this improvement in the appearance of the tubers has been observed.

With the Giant potatoes at Freehold we have obtained an earlier maturity of the crop by from six to ten days on the sulphur plots. In the case where the earlier maturity was most marked there was no decrease in the yield. Fall application of the sulphur does not produce this effect to nearly so marked a degree. It is interesting to note that this effect was not observed with Irish Cobbler and Green Mountain varieties.

In cases where the soil has been limed heavily within recent years we have not been able to obtain satisfactory results from sulphur in the control of the scab. It is well established that alkaline conditions favor the scab and as a general rule the need of remedial measures is felt most here. It is possible that the reason for this poor control lies in the fact that the oxides of sulphur would tend to combine with the alkali as soon as formed. A great part of the sulphur is oxidized to the trioxide which, with lime, would form land plaster or gypsum, a compound with little or no fungicidal property.

The experience of a number of growers has been that dusting the cut seed piece in sulphur is a good practice. Experimental work by Stoward (13) has shown that sulphur aids in the formation of an artificial skin over the cut surfaces which inhibits the evaporation of water. In cases where the seed pieces lie in the ground for several weeks before sprouting it is believed that sulphur will prevent rots of the tuber. Some writers have claimed partial control of the scab by this practice, but as a method of seed treatment against scab it is not to be compared with the formalin or corrosive sublimate treatments.

The possible place of sulphur in the system of potato culture.

From our results of this year it is apparent that the sulphur has either caused a decrease in the number of organisms in the soil or it has made the conditions so unfavorable as to destroy the virulence of the organism in part. How long this influence may last after the sulphur has been applied remains for further experimentation to determine. The results at Cornell show that the influence extends over at least the following year.

In cases where it is desired to follow potatoes with the same crop for a number of years the common experience has been that the scab attacks become worse. By using sulphur under these conditions one can practically be assured of a crop of 95 per cent. saleability.

There is also the possibility of using sulphur as a soil renovant. The actual eradication of the organism from the soil would probably take several years. Our results with the combined sulphur and formalin treatments point toward this possibility. Once the soil has been freed of organism one needs only to continue the formalin treatment to insure a clean yield.

The following summary of the sulphur work consists of tentative conclusions only, being based on but one year's work:

(1) Formalin treatment of the seed will decrease the scab even in badly infested soils and is again strongly recommended.

(2) Formalin treatment of the seed ordinarily results in an increased yield, large enough to more than pay the expense of treatment. It has been noted that where the seed has been treated the plants are much more uniform in their time of appearance above the surface of the soil.

(3) When applications of sulphur are made upon infested soils and the seed is treated we obtain a higher efficiency for each preventative measure. For example, formalin treatment under certain conditions might increase the yield of clean tubers 10 per cent. Sulphur under the same conditions might give a 10 per cent. increase also. By combining the two we might get a 30 per cent. increase instead of only 20 obtained by simple addition.

(4) Applications of sulphur at the rate of 600 pounds per acre decrease the scab normally 20 to 25 per cent.

(5) The growth of a cover crop, particularly of a legume, increases the yield from 10 to 20 bushels per acre.

(6) Sulphur is able to make a larger increase in the per cent. of clean potatoes on soil which has not produced a cover crop the year before than on a soil which has produced a cover crop.

(7) Fall application of the sulphur will decrease the scab only slightly. Fall applications have given increased yields in some instances where the corresponding spring application has resulted in a decrease in the yield.

(8) Broadcasting of the sulphur after planting gives better results than broadcasting before planting.

(9) Spring application is much more effective than fall application.

(10) Mixture of the sulphur with the fertilizer gives almost as good results as broadcasting, especially where the fertilizer is placed at a higher level than the seed piece.

(11) Spreading the sulphur in a narrow strip on top of the row after planting has given the best control of the scab. This method also results in the largest decreases in the yields.

(12) Sulphur has a greater fungicidal effect in combination with acid phosphate than with steamed bone.

(13) Sulphur makes a larger increase in the per cent. of clean potatoes when used with KCl than with K_2SO_4.

(14) Sulphur gives a greater increase in the per cent. of clean potatoes with $(NH_4)_2SO_4$ than with $NaNO_3$.

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Orchard Experiments—1914.

G. W. MARTIN.

The experiments with the use of finely divided sulphur as a spray treatment for apples and peaches, begun in 1913, were continued during the summer of 1914, in co-operation with the Department of Entomology.

Experiment With Peaches.

It was found undesirable to continue the peach experiments in the Repp orchard at Glassboro and difficulty was experienced in finding suitable plots. It was finally decided to conduct the work in the State Experimental Orchard at Vineland, made possible by the cooperation of Professor M. A. Blake, State Horticulturist. The plots were not ideal, as they were altogether too small and had been subjected to differences in fertilizing treatment, but these disadvantages were to some extent counterbalanced by the more direct control of the spraying treatments and by the certainty that securing of the final results would be assured.

The treatments were applied to five varieties, each variety in a single row and separated from the next row under treatment by a block of five rows of Elbertas. Each row was divided into blocks of five trees each, receiving respectively sulphur dust, sulphur paste, self-boiled lime-sulphur, Atomic sulphur and arsenate of lead only, the last as a check plot. The arrangement of plots is shown in the accompanying diagram. The self-boiled lime-sulphur was the regular 8-8-50 solution used for peaches, to which, in the early treatments, three pounds of paste arsenate of lead were added for the control of the curculio. The sulphur dust and paste were so applied as to put the same amount of sulphur on the trees that they would have received had they been treated with the self-boiled lime-sulphur. The atomic sulphur was used at the rate of five pounds to fifty gallons of water and arsenate of lead added as to the self-boiled mixture. The arsenate of lead alone was used at the rate of three pounds to fifty gallons. The intervening plots of Elbertas were all sprayed with self-boiled lime-sulphur.

	Dust	Paste	Lime-S.	Atomic-S.	Arsenate
Greensboro.......	XXXXX	XXXXX	XXXXX	XXXXX	XXXXX
	BLOCK	OF ELBERTAS			
Waddell..........	XXXXX	XXXXX	XXXXX	XXXXX	XXXXX
	BLOCK	OF ELBERTAS			
Mt. Rose.........	XXXXX	XXXXX	XXXXX	XXXXX	XXXXX
	BLOCK	OF ELBERTAS			
Reeves Fav......	XXXXX	XXXXX	XXXXX	XXXXX	XXXXX
	BLOCK	OF ELBERTAS			
Carman..........	XXXXX	XXXXX	XXXXX	XXXXX	XXXXX

All trees were sprayed with standard lime-sulphur solution at dormant strength on March 27th before the buds opened. The other treatments were given on May 6, May 21 and June 11. The Reeves, Mountain Rose and Carman plots were given an additional treatment on July 1.

The attempt to keep a record of the drops as was done last year had to be abandoned because of the pressure of other work but records were made of the crop as finally harvested. One of the central trees in each plot was selected as a count tree, the effort being made to select the tree which most nearly conformed to the average of the trees in the row. This selection was made just after the fruit was set and before any difference from the treatments could be apparent. All the peaches from such count trees were carefully put aside when the trees were picked and each peach was examined and graded as clean, slightly scabbed, badly scabbed, slightly marked by curculio, badly marked by curculio, slightly marked with scab and curculio and badly marked by scab and curculio. A peach was graded as clean only if it showed absolutely no sign of scab and no curculio mark. It was graded as slightly scabbed if there were found from one to a dozen scab marks, and in some cases where there were more than a dozen, if they were small and inconspicuously placed, as at the stem-end cavity. Anything more serious than this was graded as badly scabbed. From one to three or four feeding punctures of the curculio, provided the peach was not injured in appearance more than those classed as slightly scabbed, caused it to be graded as slightly marked by curculio. Several slight marks, or only one, if it caused any considerable distortion of the fruit, caused a peach to be graded as badly marked. If both scab and curculio were present but the total injury was no more than that due to a slight scabbing, it was graded as slightly marked by scab and curculio. If either or both were serious, the fruit was graded as seriously marked. There were too few in this group to make it worth while to distinguish between those badly scabbed and slightly marked by curculio, those slightly scabbed but badly marked by curculio and those seriously marred by both.

There was too little brown rot in the orchard to warrant keeping records of it.

The following table shows the results according to this classification:

GREENSBORO.

	Total No. of Peaches.	Clean.	Slightly Scabbed.	Badly Scabbed.	Slight Curculio.	Bad Curculio.	Slight Scab and Curculio.	Bad Scab and Curculio.
Dust	277	275	0	0	2	0	0	0
Paste	785	739	2	0	38	6	0	0
Self-boiled	836	783	24	11	15	1	2	0
Atomic S.	369	289	43	15	13	7	2	0
Arsenate	582	259	168	88	21	19	13	14
		Percentages.						
Dust	......	99.3	0	0	.7	0	0	0
Paste	......	94.1	.3	0	4.8	.7	0	0
Self-boiled	......	93.7	2.9	1.3	1.8	.1	.2	0
Atomic S.	......	78.3	11.7	4.1	3.5	1.9	.5	0
Arsenate	......	44.5	28.9	15.1	3.6	3.3	2.2	2.4

WADDELL.

	Total No. of Peaches.	Clean	Slightly Scabbed.	Badly Scabbed.	Slight Curculio.	Bad Curculio.	Slight Scab and Curculio.	Bad Scab and Curculio.
Dust	339	301	19	15	2	1	1	0
Paste	432	348	54	24	6	0	0	0
Self-boiled	699	239	195	253	7	0	5	0
Atomic S.	401	154	129	98	5	0	1	14
Arsenate	162	27	68	62	1	0	3	1
		Percentages.						
Dust	......	88.8	5.6	4.4	.6	3	.3	0
Paste	......	80.6	12.5	5.5	1.4	0	0	0
Self-boiled	......	34.2	27.9	36.2	1.0	0	.7	0
Atomic S.	......	38.4	32.2	24.4	1.3	0	.2	3.5
Arsenate	......	16.7	41.9	38.2	.7	0	1.8	.7

MOUNTAIN ROSE.

	Total No. of Peaches.	Clean	Slightly Scabbed.	Badly Scabbed.	Slight Curculio.	Bad Curculio.	Slight Scab and Curculio.	Bad Scab and Curculio.
Dust	263	254	1	0	8	0	0	0
Paste	622	570	35	0	16	1	0	0
Self-boiled	859	699	98	27	25	8	2	0
Atomic S.	186	147	27	5	1	2	3	1
Arsenate	75	5	40	15	0	0	7	8
		Percentages.						
Dust	......	96.6	.4	0	3.0	0	0	0
Paste	......	91.6	5.6	0	2.6	.2	0	0
Self-boiled	......	81.4	11.4	3.2	2.9	.9	.2	0
Atomic S.	......	79.	14.5	2.7	.6	1.1	1.6	.5
Arsenate	......	6.7	53.3	20.	0	0	9.3	10.7

REEVES FAVORITE.

	Total No. of Peaches.	Clean	Slightly Scabbed.	Badly Scabbed.	Slight Curculio.	Bad Curculio.	Slight Scab and Curculio.	Bad Scab and Curculio.
Dust	49	40	4	0	4	1	0	0
Paste	53	45	3	1	2	2	0	0
Self-boiled	46	31	5	3	5	1	1	0
Atomic S.	189	108	47	6	20	5	2	1
Arsenate	25	5	10	4	0	0	2	4
		Percentages.						
Dust	......	81.6	8.2	0	8.2	2.0	0	0
Paste	......	84.9	5.6	1.9	3.8	3.8	0	0
Self-boiled	......	67.3	10.9	6.5	10.9	2.2	2.2	0
Atomic S.	......	57.1	24.9	3.2	10.6	2.6	1.1	5
Arsenate	......	20.	40.	16.	0	0	8.0	16.0

CARMAN.

	Total No. of Peaches.	Clean	Slightly Scabbed.	Badly Scabbed.	Slight Curculio.	Bad Curculio.	Slight Scab and Curculio.	Bad Scab and Curculio.
Dust	1331	1262	17	4	41	7	0	0
Paste	977	925	29	1	16	6	0	0
Self-boiled	977	826	96	32	10	12	1	0
Atomic S.	1282	924	268	60	20	7	1	2
Arsenate	1610	737	573	259	24	5	7	5
		Percentages.						
Dust	......	94.8	1.3	.3	3.1	.5	0	0
Paste	......	94.7	3.	.1	1.6	.6	0	0
Self-boiled	......	84.6	9.9	3.2	1.0	1.2	.1	0
Atomic S.	......	72.1	20.9	4.7	1.5	.5	.1	.2
Arsenate	......	45.8	35.6	16.1	1.5	.3	.4	.3

The most striking feature of the tables is the almost perfect control secured by the use of the sulphur dust and paste applications against the scab, indicating plainly that these treatmens were far more efficient in the control of this trouble than the self-boiled lime-sulphur. It must

be borne in mind, however, that the lime-sulphur solution gave in every instance what could be considered a satisfactory control from a commercial viewpoint.

The slight advantage in the control of insect and fungous troubles was more than offset by the damage to the foliage of the trees treated with the dust and paste preparations. This was first noticed during the latter part of June when the leaves of these trees became covered with purplish spots, the centers of which soon fell out, causing an injury similar to that due to an attack by one of the peach leaf-spot fungi. By the first of July the condition of the trees was serious, many of the leaves had fallen and the injured leaves continued to fall during the months of July and August. The peaches from these trees ripened earlier than those on the uninjured trees and were of markedly inferior quality, being insipid and tasteless. The bearing capacity of the trees in 1915 cannot fail to be affected by this defoliation. The damage was greatest on the trees treated with the paste, and slightly less on the trees treated with the dust, due, perhaps, to the greater adhesion of the former preparation. The trees treated with atomic sulphur were similarly damaged, but to a considerably less extent. The foliage of the remaining two plots kept in good condition throughout the season.

As was to be expected, there was a considerable difference in the damage done to the different varieties. Carman was most seriously injured, Greensboro, Waddell, Reeves Favorite and Mountain Rose being successively less injured in the order named.

It has been suggested that, by combining the sulphur dust with air-slaked lime and the paste with milk of lime, the perfect control secured by the sulphur might be secured and at the same time the danger to the foliage eliminated. This is yet to be determined.

Experiments With Apples.

The apple experiments were conducted in the orchard of Mr. John H. Barclay, at Cranbury, a young and vigorous orchard of seven-year old trees which had received excellent care. The orchard contained several varieties, running fairly regularly across the plots, of which observations were taken on Yellow Transparent, Dutchess and Rome Beauty only. The object in these experiments, as in those with the peaches, was to test the efficacy of finely divided sulphur and arsenate of lead in controlling insect and fungus diseases as compared with the standard treatments. The insects which were injurious were the curculio, the codling moth and the apple aphis. The aphis was controlled by a separate spraying of Black Leaf 40, and does not enter into the records, while the damage done by the codling moth was insignificant. The only fungus disease of importance was the scab. This appeared in very slight degree on the Duchess, almost entirely upon the leaves, and in much greater degree on the Rome Beauty, where it attacked both the leaves and the fruit. As it happens, this is just the disease for which it is claimed the sulphur dust may be used to best advantage.

The part of the orchard used in the experiment was divided into five plots, each containing four rows of six trees, or a total of twenty-four trees

in each plot. The entire orchard received a thorough spraying with Scalecide and summer sprayings were planned as follows: (1) Cluster-cup stage; (2) at blossom fall; (3) ten days to two weeks after blossom fall; (4) four weeks after blossom fall, and (5) eight weeks after blossom fall. Plot 1 was used as a check plot, receiving powdered arsenate of lead at the rate of one and one-half pounds to fifty gallons of water. The final spraying was omitted on this plot. Plot 2 was sprayed with Pyrox at the rate of eight pounds to fifty gallons of water. Plot 3 received commercial lime-sulphur, one and one-quarter gallons to fifty gallons of water, to which was added in all but the last treatment one and one-half pounds of powdered arsenate of lead. Plots 4 and 5 were treated with finely divided sulphur containing ten per cent. arsenate of lead. Plot 4 was sprayed with a solution or rather, suspension of this material at the rate of ten pounds to fifty gallons of water. On Plot 5 it was applied as a dust by means of an engine and blower similar to those used at Vineland.

Because the different varieties of trees in the plots blossomed and dropped their petals at different times, it was necessary to extend the earlier treatments over several days. Furthermore, as there were peach trees planted between the rows in all the plots, it was necessary to delay the lime-sulphur and Pyrox treatments until such times as there was no wind which would blow the spray upon the peach trees and cause injury to their foliage*. Finally the elbow and delivery tube belonging to the dust blower were not shipped with the machine and it was necessary to improvise them for the earlier treatments. The improvised elbow did not work satisfactorily, at times clogging and cutting down the flow of dust and at times wasting the material. For all of these reasons it was found impossible to keep a record of the cost of the materials.

The arsenate of lead used alone on Plot 1 did not spread satisfactorily and failed to protect the fruit from curculio injury. This was particularly severe on Yellow Transparent, nearly every apple being marked from one to several times. The Yellow Transparent on Plots 4 and 5 were also rather seriously injured, although to a lesser degree than those in Plot 1, while in Plots 2 and 3 the injury was very slight. The Dutchess apples were also marked less severely but about in the same proportions.

Scab began to develop on The Rome Beauty leaves early in August and became increasingly severe as the season progressed. For purposes of record, two trees in each plot were selected and all of the apples borne were carefully graded and counted. This count included the mature windfalls as well as the picked apples, although there were relatively few of the former. As will be seen by referring to Table I, the damage by curculio and codling moth was relatively insignificant on this variety and the record really resolves itself into one of scab control. For this purpose, the insect injury can be disregarded and all of the scabbed apples combined as in Table II. It should be said that all apples with from one to a few

*This precaution was not considered necessary in the case of plots 4 and 5, and the treatments were applied when there was sufficient wind to blow the material upon the peach leaves. The result was a defoliation of the peaches similar to that noted at Vineland.

spots not aggregating more than a square centimeter in area and not too conspicuously placed were classed as slightly scabbed, and any showing greater injury than this as badly scabbed. Table III gives the percentages of scab on the individual trees while in Table IV apples from both trees in each plot are combined and the percentages for the separate treatments computed.

It will be noted in the first place that the scab infection was not epidemic in the untreated plot, and in the second place that none of the treatments gave a complete control. The apples on the check plot were seriously enough injured to present a decidedly unsatisfactory appearance. Those treated with Pyrox were good except for a certain amount of copper injury, slight on the individual apples but enough to noticeably impair their general finish. The apples treated with the sulphur solution were small and poorly colored and the fact that these trees were somewhat more heavily laden with fruit than the others is hardly sufficient to account for the difference. On the other hand, there are no facts to demonstrate that this could have been in any way due to the form of the sulphur application. The apples treated with lime-sulphur and with the sulphur dust were alike noticeable for their superior finish and general excellent appearance.

The results seem to indicate that the sulphur dust treatment may be fairly comparable to the ordinary wet treatments so far as results are concerned under ordinary farm conditions. It is extremely probable that had the applications of the dust been determined very carefully by local weather conditions the control would have been much higher, but this was impracticable under the conditions in which it was conducted and is likely to be impracticable for the fruit growers, at least for some years to come. The chief advantage claimed for the sulphur equipment is its rapidity of application, permitting the grower, when weather conditions favorable to scab infection occur, to protect a much larger area of his orchard in a given time and with the same labor cost, than is possible with a wet spray. This advantage is of doubtful value under New Jersey conditions, while against it must be charged the greater cost of the material used and the necessity for maintaining a wet spraying apparatus in addition to the dusting machinery, for applying the dormant spray and for protection against the aphis when it occurs. We cannot yet feel warranted in recommending this material to New Jersey farmers.

Table I.

		Clean.	Slightly scabbed.	Badly scabbed.	Codling moth.	Codling moth and slightly scabbed.	Codling moth and badly scabbed.	Curculio injury.	Curculio and slightly scabbed.	Curculio and badly scabbed.	Number of apples on trees.
Check Plot	Tree 1	79	20	17	2	....	...	11	1	....	130
Check Plot	Tree 2	413	123	124	6	3	1	29	8	5	712
Pyrox Plot	Tree 1	514	34	40	....	.	.	13	1	1	603
Pyrox Plot	Tree 2	550	69	47	2	..	..	11	.	2	681
Lime-S. Plot	Tree 1	590	13	15	12	1	.	20	...	2	653
Lime-S. Plot	Tree 2	599	31	36	8	1	..	10	..	...	685
Sulphur Sol. Plot	Tree 1	658	49	70	6	.		23	1	...	807
Sulphur Sol. Plot	Tree 2	566	75	67	8	5		19	2	2	744
Sulphur Dust Plot	*Tree 1*	*420*	*31*	*43*	2	...	1	*26*	7	2	532
Sulphur Dust Plot	Tree 2	588	58	47	4	.	..	26	7	3	733
		4,977	503	506	50	10	2	188	27	17	6,280

Table II.

Classed with reference to scab only.

		Clean.	Slightly Scabbed.	Badly Scabbed.	Total.
Check Plot	Tree 1	92	21	17	130
Check Plot	Tree 2	448	134	130	712
Pyrox Plot	Tree 1	527	35	41	603
Pyrox Plot	Tree 2	563	69	49	681
Lime—S. Plot	Tree 1	622	14	17	653
Lime—S. Plot	Tree 2	617	32	36	685
Sulphur Sol. Plot	Tree 1	687	50	70	807
Sulphur Sol. Plot	Tree 2	593	82	69	744
Sulphur Dust Plot	Tree 1	448	38	46	532
Sulphur Dust Plot	Tree 2	618	65	50	733

Table III.

Percentages of scab—separate trees.

		Clean.	Slightly Scabbed.	Badly Scabbed.	Total.
Check Plot	Tree 1	70.8	16.1	13.1	100
Check Plot	Tree 2	62.9	18.8	18.3	100
Pyrox Plot	Tree 1	87.4	5.8	6.8	100
Pyrox Plot	Tree 2	82.7	10.1	7.2	100
Lime Sulphur Plot	Tree 1	95.3	2.1	2.6	100
Lime Sulphur Plot	Tree 2	90.1	4.7	5.2	100
Sulphur Sol. Plot	Tree 1	85.1	6.2	8.7	100
Sulphur Sol. Plot	Tree 2	79.7	11.0	9.3	100
Sulphur Dust Plot	Tree 1	84.2	7.1	8.7	100
Sulphur Dust Plot	Tree 2	84.3	8.9	6.8	100

Table IV.

Percentage of Scab—Combined.

	Clean.	Slightly scabbed.	Badly scabbed.	Total.
Check Plot	64.1	18.4	17.5	100
Pyrox Plot	84.9	8.1	7.0	100
Lime S. Plot	92.6	3.4	4.0	100
Sulphur Sol. Plot	82.5	8.5	9.0	100
Sulphur Dust Plot	84.3	8.1	7.6	100

Orchard Experiments With Pears.

The experiments with pears were of a preliminary nature only and were for the purpose of comparing the values of various standard sprays in maintaining the vigor of the foliage and increasing the quality of the fruit, while at the same time a general survey could be made to determine just what diseases are prevalent in the State and to what extent each demands treatment.

The following diseases have been particularly noted during the past season:

Blight (*Bacillus amylovorus* [Burr.] De Toni). This disease continues to be widespread and severe and is responsible for the fact that many of the better varieties, which are more susceptible to the disease, are now so little grown in the State, having been replaced by the relatively resistant Kieffer, in spite of the poor quality of the latter. No spraying treatment is at present expected to affect this disease.

Black Fruit and Leaf Spot (*Fabræa maculata* [Lev.] Atk.). This disease, associated with the *Entomosporium* stage of the fungus, is very common throughout the State and in some seasons causes serious losses by defoliating the trees and spotting the fruit. During the past season, it was not particularly serious in most localities.

Ashy Leaf Spot (*Mycosphærella sentina* [Fr.] Schr.). This, the so-called *Septoria* spot, occurred in several widely separate localities, and is probably of general distribution in the State, but seems to be nowhere serious.

Scab (*Venturia pyrina* Aderh.). This disease is exceedingly serious upon some varieties while others are nearly free from it. Kieffer is included in the latter group, while LeConte, Lawrence and Sheldon are sometimes almost completely covered with the velvety black growth of the fungus. When severe, it causes large cracks on the fruit and in the case of Le Conte and Lawrence pears it has been observed in such cases to be associated with pink rot (*Cephalothecium roseum* Cda.), while the fruit was still upon the tree.

Brown Blotch of Kieffer Pears (cause not known). This is perhaps the most serious trouble on Kieffer pears in New Jersey. It takes the form of irregular blotches, bright reddish brown in color and scattered irregularly over the surface of the fruit. The spots tend to coalesce, especially at the stem and blossom ends, and, while much of the injury is superficial, it spoils the appearance and sale of the pears, and it seems to injure the keeping qualities of the fruit so that affected pears shrivel up and rot much sooner than those which are not affected. It also appears to be more severe on small and poorly developed pears than on the larger ones. This may be because the epidermis of such fruits is so injured as to interfere with their development by failing to protect them from evaporation. This point, together with the actual cause of the trouble, is yet to be determined.

The disease is amenable to spray treatment, as will be indicated in the discussion of the experimental work.

There were other diseases present, among which may be mentioned black rot and crown gall, but these seem to have been of minor importance.

The principal experimental work was conducted in the orchard of Mr. E. L. Bolles at Vineland. This orchard contained 215 mature trees which had received cultivation and fertilizer, but were somewhat in need of pruning and in which the blight had not been cut out for some time. The entire orchard received a dormant spray of commercial lime-sulphur, 1-9, and arsenate of lead at blossom fall and for the summer treatments. It was divided into fifteen plots of approximately equal size. Eight of these were sprayed with Bordeaux mixture, two with Pyrox, two with Atomic sulphur, two with lime-sulphur and one was left unsprayed. The Bordeaux sprayings were planned to give indications as to the times at which spraying is of most value, while the other plots were planned as checks upon the Bordeaux sprayings. The only serious insect pests were the codling moth and the psylla. Arsenate was added to all of the earlier sprays except Pyrox for the control of the former and Black Leaf 40 to all the later sprayings in an attempt to control the latter. The attempt, it may be added, was only very partially successful. It is desirable that in any future experiment the orchards be secured and the plans made early in the season so as to permit the winter treatment of the psylla as recommended in Geneva Bulletin 387.

Inasmuch as the original plans were not completely carried out, it seems proper to substitute for them a list of the actual treatments given.

The Bordeaux used was made according to the 4-4-50 formula. The last lot, applied August 7th on Plots 1 and 7, was made with an inferior grade of lime and the resulting defoliation and severe spray injury on the fruit may be attributed to this cause. The lime-sulphur, testing 27 Beaume was used at the rate of seven and one-half pounds to 50 gallons, the Atomic sulphur at the rate of eight pounds to 50 gallons and the Pyrox at the rate of eight pounds to 50 gallons. The following list gives the detailed treatments:

Plot 1. Bordeaux—May 15, June 2, July 9, August 7.
Plot 2. Bordeaux—May 15, July 9.
Plot 3. Bordeaux—May 15, June 2, June 17, July 24.
Plot 4. Bordeaux—May 15, June 17.
Plot 5. Bordeaux—May 15, June 2, June 17, July 24.
Plot 6. Bordeaux—June 2, June 17.
Plot 7. Bordeaux—Jnne 17, July 9, July 24, August 7.
Plot 8. Bordeaux—June 17, July 24.
Plot 9. Check—Arsenate only.
Plot 10. Lime-sulphur—May 15, June 2, July 9, August 6.
Plot 11. Lime-Sulphur—May 15, July 9.
Plot 12. Pyrox—May 15, June 2, July 9, August 6.
Plot 13. Lime-Sulphur—May 15. Atomic Sulphur—June 2, July 9, August 6.
Plot 14. Lime-Sulphur—May 15. Atomic Sulphur—July 9.
Plot 15. Pyrox—May 15. Atomic Sulphur—July 9.

The three most serious troubles in the orchard were the brown blotch, the black fruit and leaf spot and copper injury. The brown blotch was very severe on Plots 6, 9 and 11; severe on Plots 2, 3, 4, 10, 14 and 15; moderate on Plots 1, 8 and 13, and light on Plots 5, 7 and 12. Plot 6 received no spray after June 17; Plot 9, on which the trouble was most serious, was the check plot; Plot 11 received but two spray treatments with lime-sulphur. All of the plots on which good control was secured were sprayed four times with either Bordeaux or Pyrox, and the treatments continued to the end of July or the first part of August. Plots 10 and 13 both received late sprayings with lime-sulphur and atomic sulphur, which were not successful in either case in controlling this trouble. The indications are that a couple of treatments with Bordeaux, one the early part of July and one the first part of August, will control this disease.

Copper injury, in the form of enlarged and russeted lenticels, was severe on all of the Bordeaux plots, although less so on Plots 4 and 8, both of which received but two treatments, than on the others. It was relatively slight on Plot 12, sprayed with Pyrox, and absent from the other plots. Spray injury, taking the form of russeted fruits, was noticeable on the lime-sulphur plots and relatively slight on the others.

The black fruit and leaf spot was not severe anywhere in the orchard, although present to a considerable degree on both the fruit and leaves of Plot 9, the check plot, and Plot 11, sprayed twice with lime-sulphur. It appeared very late in the season on the leaves in Plots 14 and 15 and to a very slight extent in Plots 10 and 13. It did not occur in any of the Bordeaux plots, nor in Plot 12, given the full treatment with Pyrox.

To sum up, the results tend to show that, while Bordeaux mixture, when properly applied, will control both brown blotch and the black spot, its tendency to injure the fruit makes it desirable to weaken the mixture very much for the earlier applications, say to a 2-3-50 mixture, or to substitute lime-sulphur for these sprayings. The later applications could then be made stronger, if desired, although it is possible that the weak solution would be strong enough even for these. Further experiment is necessary to determine this point.

Cooperative experiments with the three principal sprays used—lime-sulphur, Pyrox and Bordeaux mixture—in the orchards of Mr. S. C. DeCou, Moorestown; Mr. W. H. Jones, Glassboro, and Mr. H. G. Taylor, Jr., Riverton, showed the lime-sulphur solution to be the most satisfactory of the three. In the DeCou orchard Pyrox gave the poorest results. In the Taylor orchard the mid-season treatments with Bordeaux caused such serious defoliation that the later treatments were omitted. No satisfactory explanation of this was found. There were no serious troubles in the Jones orchard—a young one, just coming into bearing—and there was, therefore, little difference between the various plots. Acknowledgements are due to all the growers mentioned for their interest and cooperation.

Owing to the sudden rise in the price of sugar coincident with the outbreak of war in Europe, the market for Kieffer pears was seriously affected, as many of them are taken by canneries under normal conditions, and these concerns could not use them while sugar remained high. For this

reason many growers are likely to feel that it is not profitable to spray this crop. These conditions, however, are merely temporary, and, in preparing for the future development of the fruit-growing industry in this State, it is highly important that we know very exactly just what spray treatments will be most advantageous to this important crop. Next year's experiments should test the suggestions resulting from this season's work and should also include as many varieties in addition to the Kieffer as is found practicable.

Jonathan Spot Rot.[1]

MEL. T. COOK and G. W. MARTIN.

This very troublesome rot disease of the Jonathan, and of some other apples, has been under observation for the past three years. The spots appear, frequently in great abundance, in or soon after the fruit comes from cold storage and greatly reduce the market value. They may also occur on mature fruit in the orchard, especially if picked late. The spots are small, seldom more than 1 cm. in diameter, usually circular. brownish or black in color and slightly sunken. A lenticel in the center of the spot indicates that the infection may be through that point. Irregularly shaped spots of the same character are also found about minute fruit cracks. The diseased tissue is dry, shallow, and can be readily separated from the underlying healthy tissue. The spot can be readily distinguished from the Baldwin spot and the New Hampshire fruit spot. The writers have found this same spot on Nero, Smokehouse and Newtown Pippin. Scott and Roberts report the same spot on Esopus (Spitzenberg), Yellow Newtou, Grimes Golden and Arkansas Black. Stakman and Rose report this or a similar disease as serious on Wealthy, Wolf River and Peter, and occurring on Peerless, Red Mirror, Hibernal and Patten's Greening in Minnesota.

A large number of cultures prepared by the writers gave more than 90 per cent. *Alternaria*. Stackman and Rose found 70 per cent. of all spots infected with *Alternaria*. However, the fact that *Alternarias* are so common on decaying vegetable matter has led to some doubt with us and other workers as to whether the spot is caused by this organism, or initiated by some other cause and later infected by the *Alternaria*.

Scott and Roberts are inclined to believe that the spot is purely physiological and the infection secondary. They say that "Nearly 400 cultures of the disease spots have been made in various ways and on various media, but no organism has been isolated with any degree of consistency. A species of *Alternaria* often occurred in cultures from fruit grown in the eastern part of the country, but cultures from northwestern-grown fruit were almost entirely barreu. A few appareutly successful inoculations were made by spraying *Alternaria* spores on Jonathans kept in moist chambers and the fungus re-isolated, but both Jonathan and Esopus (Spitzenberg) are so susceptible to the disease than they are apt to become spotted under any conditions outside of cold storage. In some cases both the inoculated fruit and the controls contracted the disease at about the same time. Spores of this fungus inserted through needle punc-

[1] *The following papers on this disease have been published:*
Mel. T. Cook and G. W. Martin—Phytopathology 3: 119-120 (1913).
Mel. T. Cook and G. W. Martin—Phytopathology 4: 102-105 (1914).
G. W. Martin—Phytopathology 5: (1915).
Scott, W. M. and Roberts, J. W.—*U. S. Dept. of Agriculture, Bureau of plant Industry* ·ular 112: 11-16 (1913).
Norton, J. B. S.—Phytopathology 3: 99-100 (1913).
Stakman, E. C. and Rose, R. C.—Phytopathology 4: 333-336 (1914).

tures failed to produce the disease. As *Alternaria* is very commonly associated with rotting apples, especially when the fruit is placed in cellar or basement storage, the possibility of its being the cause of this disease becomes very remote."

Norton calls attention to experiments in which he produced a spotting on Jonathans and other varieties by exposing them to formaldehyde and ammonia gas. He calls attention to the fact that "Some badly pitted apples from cold storage had a very conspicuous ammonia-like odor in their paper wrappings, which suggested the idea that ammonia from the cooling apparatus might be a common cause of the Jonathan spot."

In 1913 we bagged a large number of apples at intervals throughout the growing season, believing that, if the disease was due to an *Alternaria*, we could protect the fruit from infection and thus produce clean apples, while, if due to physiological causes, the apples in the bags would develop the spots the same as those that were unprotected. The trees were sprayed with lime-sulphur for scale before the opening of the buds, again for scab before the opening of the flower buds and again for scab and codling moth after the falling of the petals. The first bagging followed this spraying and therefore these fruits received no other treatments. Some of the fruit which was bagged later in the season received the regular additional summer treatments with self-boiled lime-sulphur. The bags were made of "glassine" paper which was semi-transparent or translucent and slightly water proof. These were fastened by first wrapping cotton about the twig above the fruit and then tying the neck of the bag firmly at this point. This prevented injury to the twig and the entrance of spores from the outside. No attempt was made to sterilize the fruit or twigs before covering them with the bags, and, of course, it is recognized that some spores were probably inclosed with the fruit. This first lot of about three hundred apples was bagged on May 9 and lots of two to four dozen were bagged at frequent intervals thereafter until August 15. A very large number of those bagged early in the season dropped from natural causes; while in the case of those remaining, as well as of those bagged later in the year, so many of the bags were injured by hail and rain storms that it is not possible to announce any definite conclusions. The fruit was picked October 3; part put in cold storage and part brought directly into the laboratory for immediate observation. Records were made November 12, 1913, and January 8, 1914. Although the loss of apples due to storms was so great that we hesitate to draw conclusions, a few statements can be made.

It will be noted that the bagged apples were in far better condition than those that were not bagged. This may be considered a fair representation of the results obtained. If the spot is physiological, it appears that we might reasonably expect approximately as much spotting on the fruit in the bags as on that not in bags. On the other hand, the fact that we did not disinfect fruit or twigs before bagging makes it possible that some spores were imprisoned in the bags and were the cause of the spotting.

1. The number of spots on apples bagged previous to June 9 was much less than on those bagged after that date.

2. The relative injuries due to spotting may be expressed in the following incomplete table:

Date of Examination.		Apples without spots.	Apples with few spots.*	Apples with many spots.
November 13, 1913	Bagged apples	72	18	10
November 28, 1913	Bagged apples	42	39	19
January 8, 1914 (Part of same fruit as inspected November 13, 1913).	Unbagged apples	21	47	32

* Apples with ten or less spots.

3. The smaller, nearly black, typical "Jonathan" spots are commonly confined to the dark area of the skin.

4. The rather large, light-brown "Alternaria" spots are more common on the lighter area of the skin.

5. There are spots occurring on any area which are hard to classify as one one or the other of the above and which grade into one or the other. These are not so common as the clearly distinguishable spts.

6. Many of the "Jonathan" spots are surrounded by a light-brown area characteristic of the "Alternaria" spots.

The orchard experiments were continued in 1914 but, owing to the pressure of other work, these investigations were not as extensive as hoped for early in the season. The number of spots on apples bagged previous to June 9, 1913, was much less than on those bagged later in the season. Therefore, it was decided to bag only two lots of apples in 1914, one lot shortly before June 9th and one lot about two months later. Accordingly, 200 apples were bagged on June 5th and 6th and a little more than 100 on August 14th. The method was the same as that used in 1913. The bagged apples were picked on October 5th and 6th and, without removing them from the bags, they were placed in ordinary peach baskets and stored in a cool cellar until November 12th, when they were examined and sorted into three grades: clean, slightly spotted and badly spotted. The grading was somewhat more critical than that of 1913; apples with from one to five spots, aggregating not more than one square centimeter in area and not conspicuously placed being classed as slightly spotted, while anything more caused an apple to be classed as badly spotted. At the same time 200 No. 1, unbagged apples from the same trees were examined and classified as a check. However, the check had been stored in a different cellar under somewhat more favorable conditions than the bagged fruit, in that the temperature was slightly lower and more constant than in the cellar in which the bagged apples were stored. The results were as follows:

	Clean.	Slightly Spotted	Badly Spotted.	Total.
Bagged June 5 and 6	58	25	27	110
Bagged Aug. 14	39	31	31	101
Not bagged	73	57	70	200

NOTE: The totals are not equal to the number bagged. This is due to the fact that certain fruits dropped from the stem, rotted or were otherwise destroyed after bagging.

PERCENTAGE TABLE

	Clean	*Slightly* spotted.	*Badly* spotted.
Bagged June 5 and 6	52.7	22.7	24.6
Bagged Aug. 14	38.6	30.7	30.7
Not bagged	*36.5*	*28.5*	*35*

The percentage of apples bagged June 5 and 6 which are free from rot is not so high as is the general percentage of bagged apples in 1913, but it is considerably higher than for the apples bagged August 14th and for the check. The percentage of clean fruit from those bagged August 14th is very little higher than for the check.

Although these figures are not conclusive, they tend to confirm our previously expressed opinion that the *Alternaria* is an important factor in the Jonathan spot.

A Nectria Parasitic on Norway Maple.

By MEL. T. COOK.

During the summer of 1913 the writer's attention was called to an interesting disease on a group of Norway maples growing on the private grounds of one of the residents of Princeton, New Jersey. The first symptoms of the disease were the wilting of the leaves and dying of branches very similar to the well known symptoms of the chestnut bark blight disease *(Endothia parasitica)*. In fact, it was the very striking resemblance to the chestnut blight that attracted the attention of the Superintendent of the grounds and lead to the writer's being called to make an examination. A further examination of the dead branches showed a still more marked resemblance to the chestnut bark blight; the dead branches had been completely girdled by a canker which caused a blackening and slight sinking of the diseased bark. The old cankers were covered with the orange colored pustules of the tubercularia stage of a Nectria and there was abundant evidence that this organism was the cause of the trouble.

The Superintendent had been watching the disease for some time and had removed many dead branches and cankers. Fresh wounds were very quickly attacked by the fungus, which made its first growth in the oozing sap, but the careful treatment of these wounds with antiseptics, followed by an application of paint, greatly reduced the number of infections. The breaking of the small lateral twigs from the trunk and larger branches was the most common source of natural infections and most of the cankers had started from wounds of this kind.

An inspection of the trees on the estate and in the immediate vicinity showed two others badly affected. These were destroyed, but the clump previously referred to were left standing for observation and study. During the remainder of 1913 the infected parts were removed as soon as detected and the wounds treated. In the fall of 1913 and the spring of 1914 heavy applications of fertilizers were applied to all the trees and observations continued during the sumber of 1914. The disease reappeared and the fungus was always present on the cankers but was much less severe than in 1913. The fungus was frequently found in the dead bark around old wounds, but in many cases did not appear to be parasitic. About one-third of the trees in this clump showed the fungus in 1914. Another clump of trees on the opposite side of the driveway showed but very little of the fungus. The fungus was afterwards found on the Norway maples in a nursery at Nutley, N. J., but, so far as the writer could determine, it was saprophytic or only feebly parasitic.

Specimens of the fungus were sent to Dr. C. L. Shear, who confirmed the writer's diagnosis that it was the Tubercularia stage of a *Nectria*, probably *N. cinnabarria* or *N. coccinca*.